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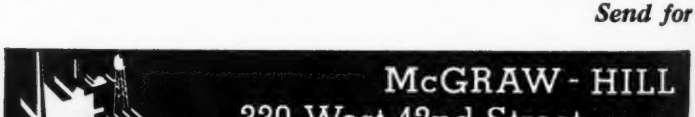

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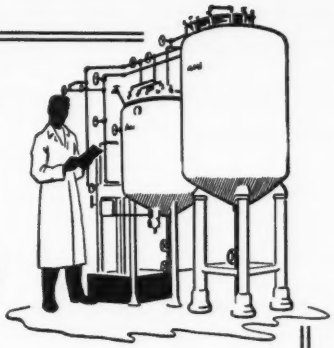

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Do You Know—

► The Graduate Study Division is investigating the possibility of undertaking a comprehensive evaluation of engineering education at the graduate level. There have been several previous studies of graduate level education, but these have not attempted to establish curricular goals or make recommendations with respect to subject matter. They were directed primarily at studying some of the major policy matters as they relate to graduate study. It is expected that this new project might be shaped up at the Annual Meeting at Urbana.

► A small writing committee completed preparation of the Interim Report of the Committee on Evaluation of Engineering Education at Raleigh, North Carolina on March 29. This draft, which will be sent to Institutional Committees for comments and criticisms, embodied the principal recommendations of some 118 institutional committees as well as the ASEE Committee on Evaluation at its Atlanta meeting. Copies of this report will be available at the Annual Meeting. The Tuesday morning General Session will feature a panel discussion by members of the committee, as well as discussions from the floor. There will be opportunities to present questions to panel members.

► The Annual Meeting plans this year portend one of the most important meetings in the history of the Society. The report of the project Evaluation of Engineering Education will be prominently featured in the General Session, as well as in many of the Division Meetings. The Division and Committee Programs, for the most part, are picking up some of the vital challenges facing engineering education as a consequence of new developments in science and technology. Over one hundred papers dealing with many vital phases of engineering education will be featured in these programs.

The ECRC and ECAC are holding a joint dinner in commemoration of the fiftieth anniversary of the founding of engineering experiment stations in this country. Dr. Lee DuBridge is the speaker. The dinner will be open to all those who wish to attend. An exhibit of research contributions is being planned.

Two of the General Sessions of the Society deal with "Creativity in Engineering" and "Recognition and Incentives for Good Teaching." The speaker at the Annual Banquet this year will be Major Lenox Lohr, President of the Museum of Science and Industry in Chicago. Major Lohr is a forceful and provocative speaker and we are assured of an outstanding banquet address. Incidentally, it was Major Lohr who organized and planned the very successful World's Fair in Chicago in 1933, which was the forerunner of World's Fairs all over the country.

The local committee at the University of Illinois, under the chairmanship of Lisle Rose, has done a superb job of planning the facilities and recreational activities for this Annual Meeting. They have determined to make this Annual Meeting a long remembered event. The ladies committee, under the chairmanship of Mrs. Lisle Rose, has outdone itself in planning a cultural and entertaining program to entrance the ladies. Mrs. W. L. Everitt, who is in charge of the children's program, has planned extensive activities which will fascinate the

youngsters of all ages and which will give the ladies an opportunity to break away from the family ties and enjoy their part in the program.

► You will be interested in reading the report on the Solid State Physics Symposium, Summer Institute Conference which was held at the University of Illinois on March 8–10, 1954. Those who attended the Conference felt that this was a highly successful venture and that it can point the way to significant improvements in certain areas of instruction in engineering curricula. A conference open to ASEE membership will be held at Carnegie Institute in Pittsburgh on June 21–25, 1954. For further information write to Asst. Dean John Grant, Carnegie Institute, Pittsburgh, Pennsylvania.

► As this issue of the Journal goes to press, plans are being completed for a similar conference of experts in Nuclear Physics in Engineering Education to be held at Columbia University on April 21–23, 1954. This will be followed by an open conference on the subject at Northwestern University on September 7–11, 1954. If you are interested in attending this conference please write to Professor Robert Young, Technological Institute, Northwestern University, Evanston, Illinois.

► May we call your attendance to the six Summer Schools being sponsored this year by the ASEE, the largest number in the history of the Society. If you are interested we recommend that you apply early, since attendance will be limited at some of these Summer Schools.

The Engineers Joint Council, which has been making substantial progress on a number of national problems bearing on engineering, is concurrently considering the possibility of developing a plan of regional affiliations and individual memberships. The regional affiliations would consist of engineering societies in the various regions of the country. The individual memberships would be on a voluntary basis and the members would receive a publication featuring articles dealing with problems which are of interest to engineers as well as views on national problems which relate to engineering. This proposal will be submitted to the constituent Society for their vote before any definite action is taken.

► Two new Branches of the ASEE have been authorized this year by the Executive Board. The Branch at the University of Illinois (Chicago Campus) is off to an excellent start with such programs as "What the ASEE is Endeavoring to Do," "Metallurgy in the Production of Cast Iron," "The Cooperative Plan in Engineering Education," and "Administrative Policies and the Faculty." Top-notch speakers have been featured at these meetings.

A new Branch has just been authorized at Purdue University. Two of the three top officers are assistant professors, attesting to the vigor and imagination of youth. We welcome both of these Branches into ASEE participation. Their positive approach in matters relating to the improvement of engineering education and the engineering profession will be a source of strength to the ASEE in the years ahead.

► We'll see you at the Annual Meeting.

ARTHUR BRONWELL, *Secretary*

Annual Meeting, June 14–18, 1954

University of Illinois
College of Engineering

By ROSS J. MARTIN

Associate Director, Engineering Experiment Station

The twenty-two buildings that house the current operations of the University of Illinois' College of Engineering will be open for inspection during the 62nd Annual Meeting of the Society, June 14–19, 1954. In addition, special displays will show growth of the College and its Engineering Experiment Station from their beginnings.

The College of Engineering was organized in 1870 to provide "courses in Mechanical Science and Art, Civil Engineering, Mining Engineering and Metallurgy, and Architecture and Fine Arts." Today it has departments devoted to the study of aeronautical, agricultural, ceramic, chemical, civil, electrical, general, mechanical, industrial, mining and metallurgical engineering, physics, and theoretical and applied mechanics.

Together with an expanding scope, the College of Engineering has grown physically from a single shop in 1895 into a well-integrated campus of twenty-two buildings, the newest of which are the Electrical Engineering, Mechanical Engineering and the Chemical Engineering buildings.

The faculty and student body have grown along with the college. Contrasted with the first graduating class of 1872, which included six engineering students, is a present enrollment of 2203 undergraduates and 570 graduates. The faculty, which consisted of a single man when the college was begun, had swelled to a staff of seventeen professors and assistant professors by 1900. There are now 372 full-time faculty members and a total staff of 583 in the College of Engineering. Although the college has grown, classes are still small and there is a continued effort to have close contact between students and their instructors.

The heritage of an early emphasis on those educational aims which today are regarded as primary is indicated in a passage from the University catalog of 1891–92: "A considerable portion of the courses of study must be devoted to general and literary work, since a graduate is now expected to arrange his ideas in clear order, and to write and speak effectively wherever it becomes necessary." The common program for freshmen follows out this idea. During his sophomore, junior, and senior years, the student's outlook is further broadened by his taking non-technical courses as electives outside his department of specialization.

Engineering Experiment Station

Stillman Williams Robinson, the first teacher in the college, believed that mathematical theory and scientific research should be blended with discussions of engineering practice—a philosophy of education still considered sound policy. Through the years the college has felt that research should go hand in hand with engineering instruction on both the

undergraduate and graduate levels. It was to expand experimental work, improve methods, coordinate efforts, and centralize the direction of experimental activities that the Engineering Experiment Station was established in 1903–04. (Iowa State and the University of Illinois will jointly celebrate the 50th anniversary of their experiment stations at the Annual Meeting.)

Since publishing its first bulletin, A. N. Talbot's "Tests of Reinforced Concrete Beams," in 1904, the Engineering Experiment Station has issued 422 bulletins, 65 circulars, and 50 reprints. Among the older continuing projects of the station are studies of railroad rails, heating and air conditioning, high speed tool steels, and boiler water treatment for power boiler equipment. Currently over 200 research programs are in progress with annual expenditures of over three and a half million dollars. In addition to studies vital to our present defense program, research is being conducted on transitors, tool steels to resist high temperatures, nuclear and solid state studies, structural engineering, and the effects of radio-active sewage on present-day treatment techniques.

Talbot Laboratory is among the outstanding laboratories on the engineering campus. The department of Theoretical and Applied Mechanics and some portions of the Civil Engineering department are housed in this building. In a 40×147-foot room in the central portion of this building is located the 3,000,000-pound Emery-Tatnall materials testing machine which has a vertical height sufficient to accommodate specimens 38 feet long for testing materials in tension and compression. The laboratory also contains numerous machines for studying materials under repeated loads, in bending, tension, compression, torsion, and impact.

Special Laboratories

The 10,000-cycle network analyzer, designed and constructed to solve power distribution and other network problems, is located in the new Electrical Engineering building. Special laboratories for studying electrical circuits, electrical measurements, and servomechanisms are also located in this building. An intensive research program in the field of physical electronics—transitors, semiconductors, millimeter and microwave propagation and antennas—is housed in the Electrical Engineering Research Building.

The new Mechanical Engineering building contains one of the most modern internal combustion laboratories in the country. It houses gasoline and diesel engines connected to dynamometers for performance testing. There is also a full-scale engine testing room containing an air-cooled aircraft engine connected to a dynamometer. Intake and exhaust pressures can be changed to simulate altitude conditions from 1000 feet below to 20,000 feet above sea level. Temperatures can be varied from -40 degrees to 150 degrees Fahrenheit. This building also houses laboratories for research and study in heat transfer, thermodynamics, precision measurements, machine design, and control systems, as well as the machine shop and welding laboratory for student instruction.

Other points of interest are the million-dollar Illiac, the electronic digital computer of the University of Illinois, located in the Engineering Research Laboratory, the shock tube in the Aeronautical Engineering Laboratory, and the 300-million electron volt Betatron housed in the Physics Research Laboratory.

Members of ASEE and their guests may visit these and other buildings and laboratories which will be open for inspection throughout the week of the Annual Meeting.

In addition, those coming to or returning from the Annual Meeting via Chicago will wish to visit the facilities of the Chicago Undergraduate Division at the Navy Pier. Established in 1946,

the Division includes a flourishing department of engineering sciences with an enrollment of 1172. The first two years of work are offered in virtually all fields in which engineering undergraduate instruction is given at Urbana-Champaign.

Relations between the Chicago and downstate campuses are close. The Navy Pier has active representation on the Executive, Policy and Development, and other committees of the College of Engineering. Just as important to ASEE members, the Pier is well represented on all host-institution committees for the Annual Meeting, and also will itself serve as host to the Mechanical Engineering Division Summer School of June 18–25.

Sections and Branches

The **National Capital Area Section** of ASEE held its Mid-Year meeting on 2 February 1954 at the Whittall Pavilion, the Library of Congress, Washington, D. C. with about 60 persons present.

After reports from Secretary-Treasurer Ojalvo and sectional YET sub-chairman Artley, and announcements of committee members and various Section activities by Chairman Walther, the main part of the meeting was turned over to a presentation of two papers on "Engineering Services and Facilities of the Library of Congress" by:

(1) Dr. Raymund L. Zwemer, Chief of the Science Division, The Library of Congress
(2) Mr. Robert S. Bray, Deputy Chief of the Technical Information Division, The Library of Congress

Dr. Clement R. Brown, Head of the Bibliography Section, Technical Information Division, The Library of Congress, introduced the speakers. In his paper entitled "General Services of the Library," Dr. Zwemer presented a short history of the Library of Congress, and talked about acquisition of science publications, bibliographical controls, mechanical and electrical aids for the librarian, and some mechanical aids for delivering information.

Mr. Bray's paper on "Special Services of the Library" covered: photo duplication service, card division, consultive services, the Technical Information Division, and special libraries in the Washington, D. C. area.

There was not much time left for a question and answer period; however, Mr. Ralph Goetzenberger made some pertinent remarks about the need of good library facilities in the area if Washington, D. C. is to become the science and technology center of the United States. Mr. Goetzenberger described the movement of professional and business people to bring the Engineering Societies building to the District of Columbia.

ASEE Summer Institute Conference on Solid State Physics in the Engineering Curriculum

By GLENN MURPHY

Conference Secretary, Professor and Head of Aeronautical Engineering, Iowa State College

Editor's Note:

This conference, sponsored by ASEE, the National Science Foundation, the University of Illinois and Carnegie Institute, is the first of a series of Summer Institute Conferences to be undertaken by ASEE.

The purpose of the Summer Institute program is to bring together some of the leading authorities in certain specialized areas where there appear to be possibilities of effecting substantial improvement of engineering education. The conference reported here will be followed by an open conference at Carnegie Institute on June 21–25, 1954. For information on this conference, write to Professor John Graham, Carnegie Institute of Technology, Pittsburgh, Pa.

On March 8, 9 and 10 about two dozen engineers and physicists met at Robert Allerton Park in Illinois under the chairmanship of Dr. Frederick Seitz of the University of Illinois to discuss the relationship of solid state physics to undergraduate engineering curricula. The conference was sponsored by ASEE with the active and generous support of the National Science Foundation.

The Allerton conference was organized because of a clear recognition that the present potential contributions of solid state physics to a better understanding of engineering materials need to be emphasized. The indications are that more engineering teachers should be made aware of the potentialities of the field. The principles of solid state physics are being applied today in electrical engineering for a better understanding of semiconductors, ferrites, transistors and similar items, and applications in metallurgy are advancing the technology of metals. What is already known of the phenomena of creep and fracture of materials will have profound influences in mechanical and civil engineering design when applied in these fields.

With the technical information now available, and with the expressed interest of the Evaluation Committee of ASEE in solid state physics, it appeared to be an appropriate time to initiate a conference in the field. Similar previous conferences on unit operations, electronics, microwaves and servomechanisms have been highly successful and have had a marked influence on engineering education in the respective areas.

The basic purposes of the Allerton conference were to determine what some institutions are doing about education in this field, to consider what should be included in a course in solid state physics for engineers, and to formulate a program for a general conference on "The Impact of Solid State Science on Engineering Materials" to be held at Carnegie Tech in June.

Present Offerings in the Field

About half of the time at the Allerton conference was devoted to a consideration of the course offerings in solid state physics by various institutions. These included colleges and universities and two of the industrial organizations, General Electric and Bell Laboratories, that have training programs for newly hired engineers and scientists. From these presentations some general conclusions (applicable to the institution represented, at least) may be drawn.

1. The amount of modern physics or atomic physics included in the freshman or sophomore course in physics is small, varying from 6 to 10 clock hours in most institutions.

2. Junior or senior level courses including instruction in solid state physics are generally available. Whether they are in physics departments or in engineering depends largely on the affiliations of the individuals who are interested in developing the field.

3. A course in solid state physics is required of all engineers at a minority of schools; it is sometimes required of metallurgical engineers and more frequently of electrical engineers.

4. Most of the schools represented reported that some instruction in semiconductors, transitors and the like was incorporated in electrical engineering courses taught in the EE department.

5. Relatively few schools give laboratory instruction in solid state physics.

It was the consensus of opinion that instruction in atomic physics as a foundation for solid state physics is essential in some curricula and highly desirable in others. In the years ahead our engineering students will require a better understanding of the science of materials. This means that the emphasis in materials courses needs to be shifted from the handbook type of information to the principles of behavior of materials under various conditions of use. It appears that relatively few engineering teachers are thoroughly familiar with what is known in the field today and with the applications being made. In order to raise the level of instruction

Electrical Engineering Building University of Illinois

in this area it appears to be highly desirable to bring to the instructors a summary of recent developments in solid state physics together with an interpretation of the engineering significance of these developments.

The space-time problem, or the problem of fitting any new or additional concept into already crowded curricula, is recognized as a critical problem, and one that can best be solved on an individual basis by each institution.

Suggested Courses in the Science of Materials

Approximately one-half day was devoted to a consideration of course content, as a result of which two course outlines were evolved. One outline contained what might be taught in a one-semester, three-credit course in atomic physics and solid state science; the other involved a sequence of two three-credit courses—the first in atomic physics and the second in solid state science.

The items suggested for the one-term course outline included structure and size of atoms, crystal structure, alloy formation, discreteness of atomic levels, one-electron spectrum, Pauli exclusion principle, energy bands, electrons and holes, imperfections, vacancies, semiconductors, and dislocations.

It was considered that a course of this character, which is about one-third atomic physics and two-thirds solid state science, would give the student a picture of what solid state physics can do in his field, but is insufficient to emphasize the limitations. However, it should give the student a working vocabulary in the field and enable him to read articles on new developments, and to understand general applications of principles.

In the two-term sequence the topics suggested as being appropriate for the first term (on atomic physics) were the atomic nature of matter, fundamental particles, quantum nature of light, thermal radiations, atomic spectra, atom complex, periodic table, X-rays, wave nucleus, nuclear structure and nuclear reactions.

The second term, on solid state physics, should probably include crystal structure, building forces, mechanical and thermal properties, electrical conductivity of metals and semiconductors, dielectric properties, magnetic properties, surface properties.

The two courses outlined have essentially the same content as existing courses given by Bell Laboratory and by various universities. Several different arrangements for teaching the course or courses were discussed, ranging from a one-term course taught in physics to two one-term courses given in various engineering departments. The group was of the opinion that it was relatively unimportant where the courses were taught provided that the instructor was well qualified and thoroughly grounded in the basic modern and solid state physics.

However, there appeared to be general agreement that these courses should be given different emphasis when taught to engineering students than when taught to physics majors. For the engineering students the body of knowledge and its applications should be stressed rather than the historical development of the principles and the fine details of the derivations. However, the courses should be directed toward giving the student an understanding of the principles and not merely their application. That is, they should be directed toward forming a basis of education in the science of materials rather than being additional training in solving problems.

The Carnegie Tech Conference

The remainder of the program was devoted to the general formulation of the conference to be held at Carnegie Tech on "The Impact of Solid State Science on Engineering Materials." The general theme of the conference is to be "what is the basic content of solid state physics

and what does it have to offer the engineer?" The conference is to be set up primarily for engineering teachers to give them a picture of how the new developments in solid state physics are related to and can be utilized in modern courses in engineering materials and allied subjects.

As now planned, the first day of the conference the last week in June will be devoted to "Fundamentals of Fundamentals." An opening talk will be given on the basic structure of matter, binding forces and similar fundamental concepts. This will be followed in the afternoon with a survey of the properties of materials and an open discussion of materials and the solid state.

The Tuesday morning session is to be devoted to metals, introduction to metallic compounds, and general properties such as precipitation hardening. In the afternoon, polymers, ceramics, and cements will be discussed.

The mechanical and thermal properties of materials will be the subject of the discussion on Wednesday, with Thursday being devoted to the electrical and magnetic properties.

Surfaces of materials will be discussed on Friday morning with special attention to absorption, catalysis, and corrosion, and on Friday afternoon the conference will close with a general summary of the field of materials as related to our knowledge of the solid state.

Because of limited facilities, the conference will be limited to 150 individuals. It is hoped that engineering teachers interested in the new developments in the field can attend.

The Allerton conference closed with the adoption of the following resolution.

University of Illinois Conference on Solid State Physics in Engineering Education

Resolution

Recognizing the need for a scientific basis for the understanding of the properties of materials and for the effective use of such knowledge in the solution of engineering problems, it is the sense of this conference

I. that all engineering curricula include material on structure of matter,

II. that all engineering curricula in their advanced courses take cognizance of this physical basis of the properties of materials,

III. that the implementation of these objectives be achieved through the cooperative efforts of engineering and physics departments at each institution.

The conference recognizes fully that local situations will influence the realization of the stated objectives.

One possibility might be a course of approximately 3 semester hours in the junior year based on general physics and possibly ordinary differential equations as prerequisites and including the following topics:

Crystal Structure
Binding Forces and Crystal Types
Mechanical and Thermal Properties
Electrical Conductivity
  (*a*) Metals
  (*b*) Semiconductors
  (*c*) Salts
Dielectric Properties
Magnetic Properties
Surface Effects
Phosphors and Photoconductivity

Regardless of the department in which such a course might be offered, its objectives definitely should be oriented to meet the needs of engineering students. To insure understanding of the concepts involved, it might be desirable, though

not essential, that such a course be preceded by a course of approximately 3 semester hours on atomic physics, based on the same prerequisites and including the following topics:

Atomic Nature of Matter
  (*a*) Kinetic Theory
Fundamental Particles
Quantum Theory of Light
Atomic Spectra
  (*a*) Energy Levels
  (*b*) Spectroscopy
  (*c*) Periodic System of Elements
X-rays
Wave Nature of Matter
  (*a*) One-dimensional Wave Equation
Atomic Nucleus
Molecular Structure
  (*a*) Valence Bonds

Should it not prove feasible to offer this introductory course on atomic physics, part of the topics listed for it might be included in the outline of the material on Structure of Matter.

The individuals recorded as being in attendance at the Allerton conference were the following.

Frederick Seitz, Physics, University of Illinois
Dan H. Pletta, Head, Applied Mechanics, Virginia Polytechnic Institute
John W. Graham, Jr., Ass't Dean, Eng'g & Science, Carnegie Tech
J. E. Goldman, Department of Physics, Carnegie Tech
A. B. Bronwell, Secretary, ASEE, Northwestern University
B. R. Teare, Jr., Dean, Engr & Science, Carnegie Tech
John C. Slater, Department of Physics, M. I. T.
W. Crawford Dunlap, Jr., G. E. Research Lab, Schenectady
Ray Pepinsky, Research Professor of Physics, Pennsylvania State University
William G. Shepard, Department of Elec. Engr., University of Minnesota
Earl R. Parker, Professor of Metallurgy, University of California
T. A. Read, Department of Metallurgy, Columbia University
G. C. Danielson, Professor of Physics, Iowa State College
P. H. Miller, Jr., Professor of Physics, University of Pennsylvania.
Sidney Millman, Physical Research Department, Bell Telephone Labs
A. W. Lawson, Department of Physics, University of Chicago
M. J. Sinnott, Chem & Met. Engr., University of Michigan
K. Lark-Horovitz, Physics Department, Purdue University
L. M. K. Boelter, Dean, College of Engineering, University of California
F. S. Buffington, Engineering Division, California Institute of Technology
R. J. Seeger, Math, Phys, Engr Sciences, N S F
Ernst Weber, Head, Department of Electrical Engr, Polytechnic Inst. of Brooklyn
W. L. Everitt, Dean of Engineering, University of Illinois
Eric A. Walker, Dean of Engineering and Architecture, Penn State
R. C. Retherford, EE Department, University of Wisconsin
John Bardeen, EE and Physics, University of Illinois
Loyd P. Smith, Physics, Cornell University
J. D. Ryder, Electrical Engineering, University of Illinois
Glenn Murphy, Head Aeronautical Engr, Iowa State College

Industry's Interest in More Education for Engineers*

By L. E. GRINTER

President of ASEE, Dean of the Graduate School and Director of Research, University of Florida

There is indeed a striking comparison between the interest shown in the young engineering graduate today and twenty-five or thirty years ago. Today industry makes clear in many ways its intent to use every device for making the first five years of the graduate's industrial association contribute to his individual effectiveness When I took my first industrial job my employer made it clear to me that he was merely experimenting and that he seriously questioned whether the investment of time in training a college graduate in the ways of industry would ever pay off. After a few months I myself decided that his experiment was going to be a failure, not because I couldn't learn the ways of industry, but because he did not appreciate sufficiently the usefulness of basic engineering science—so I quit the job and went back to school.

It is worth noting that I had to quit the job to go back to school. If any evening graduate courses were given in Pittsburgh, where I was employed at that time, I was not made aware of them. If the idea of cooperative graduate study on a part-time basis existed, it was not general information. Certainly my employer had no feeling of responsibility for my further education except as an apprentice. I may have helped educate him because he seemed amazed by my decision to quit a steady job for further education. He remarked that he had fired a lot of men in his time but that I was the first one who had quit without a reason. To salve his pride he withheld a hundred dollars of my salary which he classified as the value of company effort toward my apprenticeship training. I quote this case to point out the great change that has occurred over thirty years in industry-employee relations.

Continuing Education Needed

Since we are restricted in the university by a curriculum of quite limited extent, it is necessary for the graduate to continue his education after leaving the university. He needs at least three kinds of continuing education:

(1) Special training for the job that he holds or expects to hold. This is exclusively the problem of industry since no college can effectively teach company techniques and practices.

(2) Further education in engineering or allied subjects. Evening graduate courses are provided in large cities, and home study is always available to ambitious people. Also, many progressive companies have cooperative arrangements with universities for the conduct of special courses or educational programs.

* Presented at the College–Industry Conference sponsored by the Relations With Industry Division of ASEE, Detroit, Michigan, Jan. 16, 1954.

(3) Further breadth of education is essential for good citizenship which demands a broad understanding of people and the instruments of government, politics and economic institutions.

The responsibility for these three types of continuing education is a joint responsibility of the young graduate, the employer, the university and the engineering societies. All of these influences exist, but at times they have been operating at cross purposes. No individual can react favorably if he is being pulled in three directions at the same time, which is the situation if there is no plan as to how the individual graduate can advance his three-fold education, first for his immediate job, second toward greater depth in engineering, and third toward a more liberal education.

I have long believed that interest should dictate the immedate direction of each individual's education. Whenever we find a young person studying engineering merely because his father is an engineer or an engineering professor, we know that his chances of success are limited. Of course, interests change. Every teacher has the occasional experience of having some of his brightest graduates return and admit freely that they have carried on no engineering studies after graduation. The emphasis upon training for the job has separated these graduates from their profession, and once the continuity of interest in engineering study is broken it is not likely to be reestablished.

A great deal of emphasis is being placed upon counseling of college student, but it does not appear that an equally effective system exists in all industry. The graduate's boss can not ordinarily serve as an effective counselor because the boss has immediate problems to be solved that require certain types of training which he must necesarily urge upon the new employee. The counselor should have a broader viewpoint based upon the long term needs of the company for people of all backgrounds of education. Such an individual can try to determine the interests of the young engineer and counsel him to seek further education that will provide an outlet for his interests either within the company or elsewhere. There is small merit in ruining a potential professional-scientific engineer to produce a mediocre executive or *vice versa.*

Creative Engineers in Short Supply

It is my belief that industry's greatest shortage of engineers during the next ten or fifteen years will be in the field of creative, professional or scientific work. *Engineers competent to produce creative results in research, development work and design are certain to remain in short supply no matter whether the total number of engineers becomes adequate or remains critical.* A person with long experience in the field of commercial art mentioned recently that no more than one student in ten who enters that field can be depended upon for creative work in art. I fear that about the same ratio of one in ten will limit our production of creative designers and of research and development engineers. Of course, all engineering demands a modicum of creativity since even maintenance work is seldom repetitive. However, an exceptionally high level of creativity is required for the production of research and development or novel design work. Such creative minds will always be in short supply.

To an increasing extent the possibility of developing new ideas, concepts, processes or even new hardware for industrial production requires knowledge of the engineering sciences. *Statics including elasticity and plasticity, dynamics, including vibrations, fluid flow, heat flow, thermodynamics including combustion, electric flow, electronics and electric waves, physical metallurgy and the properties of engineering materials form the*

background engineering sciences. These engineering sciences rest upon the basic sciences of mathematics, chemistry and physics, including in the near future nuclear physics and the physics of the solid state. No graduate of a four-year curriculum is likely to have an adequate background of the basic sciences and the engineering sciences if his job is to become a creative engineering scientist for industry or even a design engineer.

It is my suggestion then that industry scan most carefully its new recruits from the colleges of engineering to determine which ones have the interest and the ability to continue their education in engineering science. When located, these individuals represent a large fraction of the industrial potential for future creative activities including product development. It would be my thought that such individuals should all be given the opportunity and encouragement to complete their studies for the master's degree, and in more limited numbers to obtain the doctor's degree. Industry can well afford to invest much more heavily in the training of future creative personnel since it is unrealistic to expect young men who have already invested an average of four years and 5000 dollars in a B.S. degree in engineering to be willing to face a large added expense for graduate education without earned income. The Armed Services have long recognized the necessity of providing such training for officers wherever needed.

Educational Opportunities

When large industries face the problem of continued education for employees they find several opportunities. Sources on an evening school basis may be available near the plant or at cities within driving distance. If so, the typical rebate of tuition by the company may be adequate inducement for students who are taking undergraduate courses or courses for general education, but is is a rather negligible contribution to the graduate study of engineers. This problem needs to be restudied. For example, company fellowships for full-time graduate study of selected employees should be considered. A company may also decide to arrange with an educational institution to conduct graduate courses and special courses at the plant, or nearby, for Company students. When approached with the undertsanding that long-term educational benefits are being sought, rather than particular job training, such academic programs have real value and have been conducted successfully.

A very large company or industry may feel that it can afford a Company Institute for the training of its employees. There are examples in the automotive industry and also in the Federal Government. At a recent meeting at which a group of educators including industrial representatives were drawn together to study this problem in its relation to Federal Agencies it was concluded that the granting of degrees should not be sought by such agencies, and I am sure that the same arguments apply to industry. The immediate desire for job training is too influential in a non-academic atmosphere; the feeling of the student that education so provided must be necessary to his advancement is likely to result in classes filled with students of mediocre qualifications. There is also a lack of stability in the too frequent use of part-time teachers resulting in typically large drop-outs from classes. Academic institutions have long experience in avoiding such problems, which is really the basis of maintaining high academic standards.

With more than one hundred and sixty accredited colleges of engineering available in this country no company need fail to obtain academic sponsorship for any educational program which it desires to have conducted on a graduate or undergraduate level. However, the company should not approach a university with the idea that it can have university sponsorship and still dictate the

program itself. *The reason for university sponsorship is to obtain an impatrial influence upon the educational program that keeps it above the level of an industrial training program.* If the latter is desired, the program should be concluded by the company on a non-credit basis. *But if graduate or undergraduate credit is desired for application to a university degree, the final decisions concerning the selection of the teacher, the course content, the prerequisite study and the selection of students can only be made by the university sponsoring or operating the program.* When this necessity is clearly recognized, a working relationship should not be difficult to achieve. I believe that we need many more cooperative company-university programs at the graduate level in many engineering fields.

College Notes

The administration of teaching and research in engineering at the **University of Pennsylvania** has been completely reorganized in order to coordinate and extend the University's activities in these fields. Under the reorganization the Towne Scientific School has been divided into four separate Schools of Chemical, Civil, Mechanical and Metallurgical Engineering, each of which will have its own faculty.

Directors have been named to head the four newly-created schools and the Moore School of Electrical Engineering, while two assistant vice-presidents for engineering also have been appointed. All of these various engineering units will function under Dr. Carl C. Chambers, vice-president in charge of engineering affairs. In addition, provision has been made for the establishment of an Institute for Cooperative Research to stimulate, coordinate and manage investigative activities in the engineering field for industry, foundations and government.

Appointed directors of the five engineering schools are Dr. Melvin C. Molstad, Swarthmore, Chemical Engineering; Emory F. Stover, Gladwyne, Civil Engineering; Lee N. Gulick, Bala-Cynwyd, Mechanical Engineering; Dr. Robert M. Brick, Bryn Mawr, Metallurgical Engineering, and Dr. John G. Brainerd, West Chester, Moore School.

Industry, Engineers and the First Five Years of Professional Development*

By DR. L. F. GRANT

Chairman, Engineers' Council for Professional Development

As I am here in my capacity as chairman of the Engineers' Council for Professional Development, hereinafter referred to as ECPD, I shall confine myself to a discussion of the "First Five Years of Professional Development," commonly known as the Monteith Report, and, as it is expected that out of this meeting will grow one of the courses which that report contemplates, I think it well to tell you something of its history.

The ECPD was formed with the idea of developing the engineer in successive phases, and not of developing the profession. The first of its objects was to give adequate counselling in schools to boys who were considering entering engineering colleges. When I was a youngster, no such advice was available. Some of the older men present may remember a book about engineers written by the late Richard Harding Davis. It was a first-class adventure story and depicted the hero—an engineer—running a transit with one hand and standing off a gang of desperadoes with a gun in the other, and on the penultimate page marrying the daughter of the president of the railroad. I suppose that book was responsible for producing a larger crop of mediocre engineers than any other influence I can think of. The second was to examine and accredit the various curricula offered throughout the country to see whether they were thoroughly efficient. Now, having dealt with the boy before he goes to college, and having tried so far as is possible to make sure that the young man's college course is a satisfactory one, we come to the third of the ECPD objects, and this is the one with which we are concerned today, namely development after graduation. In this for a long time we made no progress. I myself, was chairman of a similar committee in Canada and for several years I did my utmost to try to find out what the profession can do for the young engineer—entirely without success.

What does he want? He wants a better job, and by that I do not mean of course simply more pay, but work that will constantly be a challenge to the best that is in him, that will call upon him to improve his professional knowledge, his outlook on affairs outside of the profession, and to increase his usefulness to society in general and to his employer in particular. Obviously for any organization to achieve this is a difficult task, and when in the course of time I became the Canadian representative on the ECPD Committee in charge of this project I found that whereas I had been trying for three or four years in Canada to effect some result and had got nowhere, the ECPD, had been trying for a much longer time and had got to exactly the same place.

Finally in 1949, the then chairman of the ECPD (and I am particularly glad to make this statement here) a well-

* Presented at the Relations with Industry Division, ASEE meeting at Detroit, Jan. 16, 1954.

known citizen of Detroit—Mr. James Parker of Detroit-Edison—said that he was tired of talking about this plan, that he would have a survey and a report made from which a programme could be designed and implemented, and if it was not possible to implement this programme, the ECPD should throw in its hand and decide that the project was beyond its powers.

Full Professional Stature

The eminent engineer who was chosen to make the survey and report was Dr. A. C. Monteith of Westinghouse. Dr. Monteith assembled a very competent committee of men who, as the foreword states, "were active engineers, busy in their field of endeavour, but anxious to help the rising generation attain full professional stature." Could one give any finer tribute to a group of engineers than those words?

I am glad to have this opportunity of expressing my admiration for and gratitude to them for the work they did. The report was a voluminous one.

The headings under which the "First Five Years of Professional Development" are discussed, are:

1. Orientation and Training;
2. Continued education of graduate engineers;
3. Integrating the young engineer into his community;
4. Registration of the young engineer;
5. Self appraisal methods for evaluating characteristics in engineering;
6. Reading list.

In order to produce this report a systematic survey was made of the training given by fifty-four companies in the United States which the committee classified as:

A. SMALL: those which normally employ five new young engineers every year;

B. MEDIUM: those which normally employ from five to twenty-five; and,

C. BIG: those which normally employ more than twenty-five new graduates, running in some cases into the hundreds;

beside these fifty-four companies the committee surveyed a number of others though less completely.

In nearly every case the big companies have some sort of formalized course, given in the company's time and at the company's expense. Some of the medium class are doing the same, but very few of the smaller ones are. It must be remembered, however, that in the small concern the young engineer will often obtain personal advice and direction which may well be as valuable as the more systematic courses which the larger companies are able to undertake. But obviously there are many young engineers who do not have the opportunity of receiving such beneficial training.

From the beginning it was realized that the project must have the support and co-operation of industrial leaders as well as educationalists, and it is a pleasure for me to say that every assistance possible was given to Dr. Monteith's committee by the industries interviewed, that this assistance has since been continued especially in Cincinnati where the first course is now being held, and the presence of so many industrialists here today gives further evidence that industry recognizes the need for further training of engineers if they are to make the most of themselves, not only for their own benefit, but for that of their employer.

Post-College Slump

The Report recognizes that all too many young men, when they graduate, fall into what has been called 'the post-college slump,' as a result of being removed from the affectionate care and sympathetic encouragement which they receive (especially at examination time) from us professors, and being then pitchforked into employment where the em-

ployer has the peculiar and heretical notion that the young man ought to be able to do something for himself. Some effort is needed at this stage to remind the young man that education is a continuing process (I apologize for using this somewhat shop-worn cliché but we do not seem to be able to get away from it), and that he has at least part of the responsibility for making himself more useful to his employer if he is to advance in professional responsibility and achievement.

Training thus becomes a triple partnership between industry, education, and of course, the young man himself. The constant support and the constructive and helpful criticisms which the ECPD receives from industry is most encouraging.

When the Monteith Report was presented to the annual meeting of ECPD at Cleveland in October 1950, it met with unanimous approval, and the question then became, how was it to be implemented? The main difficulty was to obtain a competent director, and after some delay the Council was very fortunate in obtaining the services of Professor Cornelius Wandmacher of the University of Cincinnati, who, after two years of hard preliminary work, inaugurated the first course in October of 1953. The details of that programme will be explained later and I am going to touch on only two or three points.

The studies which are proposed are *mainly* those of engineering, and they may, if pursued long enough, lead to a Master's degree, and even if the student does not want to go so far as that, he will be able to refresh and extend his engineering knowledge and to do some work on a post graduate level. This part of the project is necessarily the responsibility of engineering teachers.

Now what can engineers in industry, and industrialists in general do to help in this program? Well they are so to speak, the ultimate consumers of the product of engineering colleges, a product which to the industrialist is only raw material or at least only patrially processed material. You industrial men can teach the young engineer what industry expects of him; you can show him how his university education must be implemented by application and by practical experience, and you can give him that knowledge of industrial problems and their solution, which the college cannot do. How welcome such instruction will be is illustrated by the remark of one young man who was a member of a group for whom I arranged a somewhat similar course. He said to me, "We have been listening to professors for four years, now we should like to hear from the man who is actually doing the work," for which admirable opinion I congratulated him warmly.

Labour relations, company finance and management, the many problems with which industry is faced, must also form part of such a course, and here industrialists are best fitted to give instruction.

Again the young engineer does not always appreciate his duties to his profession and to the community, and this is recognized by the Monteith Report in Points 3 and 4, "Integrating the Young Engineer into his Community," and "Registration for the Young Engineer."

Development of the Young Engineer as a Man

Finally it was found that nearly every company gave in its training something outside of engineering, something which had as its object the development of the young engineer as a man, or to use an old-fashioned expression of which I am very fond, "a man of parts," by giving him some of those things which he did not get at college, or which, if he did, he was inclined to disregard as not being exactly engineering. Such things may be a better mastery of the spoken and written word, a knowledge of current affairs, both national and international, political economy, possibly as we have

tried in Canada, some introduction to the appreciation of Philosophy, of Art, of Music, and of Literature, or even The Social Graces.

The young men who participate in such a course as is proposed, both on its technical and non-technical sides, will I am sure develop professionally as engineers, as citizens, and as men of parts, so that they may in time attain to the splendid ideal written by Bacon in his preface to "Maxims of the Law," in those rolling Elizabethan periods of which Bacon was such a master:

"I HOLD every man a debtor to his profession; from the which as men of course do seek to receive countenance and profit, so ought they of duty to endeavour themselves by way of amends to be a help and ornament thereunto."

College Notes

New developments in engineering will be presented at the **Pennsylvania State University** through eight summer seminars. These include programs in Analog Computers, June 21–July 2; Color Television, June 21–July 2; Creative Engineering, June 21–July 2; Electrical Contacts, June 28–July 2; Electrostatic Precipitation, June 21–25; Mechanics of Creep, June 28–July 2; High-Temperature Properties of Materials, June 21–25; and Transistors, June 9–19. Outstanding guest lecturers will present the latest developments in these fields.

Enrollment is open to graduate engineers and scientists. Inquiries should be addressed to Prof. K. L. Holderman, 103 Mechanical Engineering Building, the Pennsylvania State University, State College, Pennsylvania.

The appointment of Dean Edward L. Cochrane as Vice President for Industrial and Governmental Relations and of Professor C. Richard Soderberg as Dean of the School of Engineering at the **Massachusetts Institute of Technology** has been announced.

A special one-week summer program in Corrosion, to summarize the fundamental and recent advances in this field, will be given at the **MIT** during the 1954 Summer Session, from June 21 through 25.

Dr. Herbert H. Uhlig, Professor of Metallurgy, will be in charge of the summer program.

Experience Tells Me*

By J. J. CRONIN

Vice President in charge of Manufacturing Staff, General Motors Corporation

A young engineer's first five years after college are, in most cases, rather long ones. As I recall it, they were for me, and I presume that I had all the problems which confront today's young engineers. Perhaps, like others today, I even went so far as to borrow some problems which did not exist. The pay in 1918 at Fisher Body for a young college graduate was thirty cents an hour, and while that was only equivalent to six hamburgers, I should say that in those days a hamburger came more nearly being a satisfying meal than does its namesake today. We worked hard and dreamed large dreams in those days just as young men do today. Similarly, we were concerned about such things as our financial progress on the job, our opportunity for advancement, our doubts as to whether our work was fully appreciated, and what we could do to better equip ourselves for tomorrow's hoped-for opportunity. I am sure that these or related problems are burdening the young engineer today.

To you as technically-minded men, my message may be disappointingly non-technical, yet this is the chance I take. I hold a great appreciation for each of the three fields which you represent but, with your permission, I would like to broaden the conventional definitions which each of your may hold for your callings or offices.

We generally think of engineers as exercising ingenuity in the design of things. I would like to extend the meaning beyond the "design of things" to include "the design of living."

We think conventionally of technical societies as existing primarily as a focal gathering point for those having a community of interest in a technology and for the dissemination of information with respect to that interest. Considering that such a group is in itself a segment of society and thus is made up in its membership of men and women with singleness of purpose, I would broaden the objectives of a technical society to include the techniques of better human relations.

Engineering educators are conventionally and properly thought of as learned folks shouldering the heavy responsibility of shaping young minds and instilling in their students the maximum of fundamental technical knowledge. I would like to lay down the challenge that engineering educators have the priceless opportunity of also helping the engineering student to shore up the crucible in which that knowledge is contained. Knowledge to be useful must be in the mind of a person of sound character or that knowledge might someday be wasted or misused.

Since I've warned you that my message will be non-technical, I'd like to tell you about a recent athletic event which took place at Briggs Stadium, Detroit. It is the home of our Baseball Tigers in summer and our Football Lions in the fall. Between Christmas and New Year's, an important athletic event took place there. The Cleveland Browns, champions of the Eastern Division of the National Football Confer-

* Presented at College Industry Conference, Relations with Industry Division, ASEE, Detroit, January 16, 1954.

ence, engaged our Detroit Lions, champions of the West. The two teams were evenly matched. Either could have been victorious or the contest could have ended in a tie and everyone, including the fans perhaps, would have been satisfied. A few days prior to the game, the quarterback and leader of the Cleveland Browns made a very significant statement to the press. This great team leader, Otto Graham, said that the league championship would be decided on the basis of "mental fitness." Translate "mental fitness" any way you wish and it adds up to a wholesome attitude—in this case, a wholesome attitude toward the job of winning a game.

From the spectators' standpoint, the game was a thriller and the championship was won by the slim margin of a point after touchdown, and I am sure that none of us in the stands would have wanted to shoulder Doak Walker's responsibility in kicking that all-important Detroit point, but he approached the job with a determination borne of right attitude.

Former President Theodore Roosevelt, a man who goes down in history as having a great depth of human understanding, left his permanent mark on our country. He left a nation proud of its own natural resources and a nation which had the righteous respect of an entire family of nations. He also left this significant account of his efforts as recorded by writer David Guy Powers.* Theodore Roosevelt said

> I stood out for my opinion alone. My own conscience, my own judgments were to decide all things. I would listen to no arguments, no advice. Finally, I learned that the things I wanted to do, I was powerless to accomplish.
> What did I do? I looked the ground over and made up my mind that there were several excellent people with honest opinions even though they differed with me. I turned in to help them and they turned to and gave me a hand, and so we were able to get things done. We did not agree on all things but we did on some and those we pulled at together.

You who are participants or guests at this conference know about the give and take of a meeting. You, too, may have had your individual differences during the day but I'm sure that you agree on the value of achieving the goal which has brought us together. In a way, the very fact that you have appeared here today indicates that you have a wholesome attitude toward the task. You recognize that a problem exists and are giving of yourselves to help arrive at a solution.

There is much in common among Otto Graham—the football quarterback—Theodore Roosevelt—the man who spoke softly more than he used the big stick—and you who are gathered here today. Otto Graham talked essentially about a wholesome attitude toward the job at hand—which in this case was the winning of a professional football game. Teddy Roosevelt spoke frankly about how he arrived at a wholesome attitude toward people. You who have come here to give of yourselves for the advancement of a worthy cause have exhibited a wholesome attitude toward living.

Successful Accomplishment

All action stems from our will to perform the action. The will grows from an idea which is allowed to develop or is extinguished by our judgment. If our judgment permits the idea to move to the stage of our determining to do something about it, the action is tempered by an elusive spark which is our attitude and our attitude can grow into a fierce flame which will determine the type or character of our action. Our attitude is the key element. A wholesome attitude underlies all successful accomplishment.

And it is at successful accomplishment

* From "Live a New Life," by David Guy Powers, copyright 1948. Reprinted by permission of Doubleday & Co., Inc.

that we aim when we discuss the engineer's first five years in industry. We —all of us—want to create a favorable climate for the young engineer so that he does not consider his work to be economic drudgery necessary to make a living but rather as an opportunity to develop and express his latent talents. We want the individual engineer to take maximum advantage of that climate and come to realize that his attitude toward work, toward living, and toward people will develop an inner satisfaction through personal attainment, attainment which is measured directly by the elastic limit of his abilities.

Have you ever paused to consider how tremendously our attitude effects our actions? We associate success with great actions whether they be sudden as in battle or on an athletic field or sustained over a lifetime as in the case of great statesmen. Men who translate their lives into great actions invariably exhibit wholesome attitudes.

Along the highway of life, each of us is attracted by some men of action, and invariably we admire them for certain personal traits. Notice how these traits are each an attitude—ambition, cheerfulness, confidence, courage, enthusiasm, integrity, loyalty, perseverance, self-control, understanding, and vision, to name but a few.

Each of these traits associated with success is the expression of a wholesome attitude toward people, toward work, or toward living generally. We are free, each of us, to assume or develop any or all of these traits. Similarly, we are free, each of us, to demonstrate a willingness to instill and develop these traits in the young men who come within the shadow of our influence.

The shadow of your influence may be longer than you think. In many ways, our founding fathers considered themselves as very ordinary folks and all of us today may look around us to see what their sound thinking has accomplished. Suppose for a moment that our founding fathers had set up a government such as that which has grown up behind the Iron Curtain. Could the same material advancement have been possible, even with our vast natural resources? History's pages are full of examples of nations which had the same material opportunity to prosper as had the United States but somehow did not achieve our benefits.

I am not one to place undue importance on our material advantages nor to say that anything American is necessarily the best in the world. However, I do certainly value and endorse the working climate of individual initiative which made our high living standard possible. Our founding fathers established a nation unique on the face of the earth because it advanced the proposition that man gets his rights from God and not from government. Between man and government, man is supreme. Man is free to make choices, good or bad.

Picture if you will the young engineer behind the Iron Curtain who could derive personal benefits from ambition, cheerfulness, confidence, generosity, integrity, and all the rest! Our young engineers—and all of us—still live under the shadow of the influence of our founding fathers. Our freedom gives us the right to life, liberty, and *pursuit* of happiness according to our own attitudes toward these three elements. We are free to demonstrate, live, and express our attitudes toward good—or evil —objectives; and our own attitudes can be very contagious.

What I've tried to point out so far is that a wholesome attitude underlies success in any venture and that we live in a unique nation where a wholesome attitude pays off for all of us. Let us try to apply a wholesome attitude to the task at hand: that of creating the right kind of climate for the young engineer in his first five years in industry —realizing, of course, that the young engineer by his work and attitudes will

bear the full responsibility for taking advantage of the opportunities available in this climate.

Industry and Education

In the area of education first of all, let us give honest recognition to the store of technical knowledge which the young man has gained on earning his baccalaureate degree in engineering. The knowledge is of sufficient value to us in industry so that we have completed briskly for next June's 19,000 graduates of U. S. engineering schools as we did for last June's 24,000 graduates. The Scientific Manpower Commission has indicated that we have a need in the United States for from 35,000 to 40,000 engineers right now and the Commission estimates that our needs to accomplish the nation's engineering tasks will continue at a level of about 30,000 new engineers per year for some time.

When engineering graduates come to us in industry, we assume a responsibility of carrying on where engineering educators leave off. While we in industry welcome and seek young engineers, we recognize that they are by no means finished products. You have trained them to *become* engineers; you were not expected to turn them out as *finished* engineers. The responsibility of undertaking further training programs is one which we gladly accept.

In our training programs, we have an excellent opportunity to discuss the value of graduate study as it might apply to each individual and in some cases we could recommend to the young engineer that he supplement his on-the-job training with formal graduate study. In General Motors, we operate under a policy of decentralized control and each operating unit establishes its own practices. But I know of no unit in which graduate work by young engineers is discouraged. In fact, we hear only of its encouragement.

Among the means taken by industry to promote the self-development of young engineers through graduate study programs are

(1) Reimbursement of tuition, provided certain requirements are met.
(2) Granting of graduate scholarships to employees.
(3) Granting to colleges and universities graduate fellowships which are filled by students who do not commit themselves to become employees of the industry which makes the grant.

Industry also promotes a closer liaison between engineering education and their employees through

(1) Bringing engineering professors into their laboratories and plants for summer work.
(2) Conducting of seminars in which professors are invited in as leaders.
(3) Conducting of conferences in which engineering educators are invited to a program of visits and lectures to better acquaint them with industry's viewpoints and to bring to industry a greater understanding of problems in engineering education.
(4) Sharing of technical information, such as we do in General Motors by providing engineer-lecturers for college classrooms and publication of a technical periodical for engineering educators.

Two Academic Camps

At a conference for engineering educators held by General Motors last summer, we learned that the educators are divided into two academic camps. One group feels that industry has grown so complex that it is no longer possible to specialize engineering education to a sufficient degree so that the graduate will be immediately profitable to industry. This group urges a return—or a continuing emphasis—on a thorough grounding in

the basic sciences. The second group feels that a student ought to be trained very thoroughly in a narrow technical field so that he can be immediately valuable in his specialty.

I have no particular preference for either academic viewpoint, and there are many others, both in my company and in industry generally, who have no strong preference either for a specialized education or a broad scientific training. The guests at our conference made a survey and appointed a spokesman from their number to summarize their findings. The Professor, from the University of Toronto, said in his talk given near the end of the 15-day conference

> The answer was quite unequivocal and a bit shocking. General Motors, judged by the composite answers, did not fall into the arms of either camp but marched bravely to a third position, stuck its banner in the ground and allowed us to see on it words emblazoned in letters of gold; we looked at one another, for those words didn't appear in the syllabus, the curriculum of either camp, and these words were thus strange to us. They were principally integrity, diligence and ability to express one's self. Humility was one, and one or two other qualities.

I do believe that the Professor from Toronto used the word "shocking" to heighten his meaning. We grew to know him quite well during the two weeks he was our guest. By his actions, he stood out to us as one who in his associations with students would definitely generate just the kinds of wholesome attitudes which industry desires, not only that the employee may make his contribution to industry but, more importantly, that he may make life satisfying for himself and for his family.

It is far more than my own personal opinion that we in business and industry have an obligation to share with the schools the responsibility of insuring that our young people are educated and trained for effective living in the world as it is, and not as some of us would like to have it. Our desire for favorable attitudes transcends any preference which we might have with respect to curricula, whether they be specialized or stress the basic sciences. It means that we think that all young people ought to be far more conscious than they are of the ultimate objective of all education and training, namely, becoming equipped to make a satisfactory living —but more importantly—to make a successful life.

Certainly, the college years are very impressionable ones for the future engineer. Professors and instructors have a superlative opportunity while indoctrinating their students in engineering knowledge to also instill the less easily defined fundamentals of effective living. In this latter task, the best teaching tool, to my mind, is the power of example.

Technical Societies

In this joint effort of ours, technical societies also have their opportunity to demonstrate to the young engineer the value of effective living as an engineer, for these societies offer a medium whereby the young engineer can obtain a broader viewpoint of his particular specialty. His society membership gives him the opportunity to hear the viewpoints of a broad cross section of engineers in his own field and to learn from their experiences.

I suggest here that technical societies make sure that their younger members have an opportunity to discuss with older members informally and quite frequently their areas of mutual interest. The society should do this as a primary "bread and butter" job; for it is quite easy for a young engineer to gain precisely the kind of technical information heard in lectures simply by visiting a good technical library. Any society also has the opportunity through its membership to disseminate information on the technique of effective living. And since it is a society, it also must offer some

social outlet to its membership. This enables the older members to set the same kind of good example which professors can set in the classroom.

Industry and the Individual

Just as the responsibilities of engineering education and industry intermingle, so do those of industry and the individual. As I've mentioned, engineering educators train and develop a young man to *become* an engineer and industry has the responsibility of creating a climate in which the graduate can express his training in work. His profession must not be permitted to lapse, as some might have it, into a simple *trade* wherein his productiveness would be measured purely by hours spent on the job (though this is necessary) rather than by his creativeness as a member of a proud profession.

Industry's responsibility is to create a good climate for creative engineering. We need to give due regard for the worth of an engineering education. We need to assure ourselves that the young engineer gets as profitable experience and training during his first years as does the medical school graduate during his internship. Further, we need to establish and maintain equitable policies and practices relating to salaries and promotions so that the young engineer will have the benefit of personal rewards commensurate with his ability to translate his engineering knowledge into work for the success, both for the business and for himself.

On-the-job training is necesary but industry would find little success in forcing its young graduates to continue in night school until they obtained advanced degrees. That step, too, is left to the individual initiative of the young engineer. He must *sense* the advantage of further formal education to equip him for making a greater contribution of himself to his company. From a practical standpoint, I cannot see how industry can arbitrarily set down practices which would guarantee progress purely on the grounds of employees obtaining advanced degrees.

The young engineer, too, has a grave responsibility in his first years. He needs to find his own definition of successful living and a way to derive the maximum benefit from both his technical education and his ability to work as a member of a team—to lean on his colleagues and to serve them at the same time. His attitude toward them and toward his work will determine his own success in developing his abilities to their elastic limit. In the final analysis, the young engineer himself has the responsibility for his own self-development.

Now we should warn the young engineer that while he might know what the ideal working and learning climate is, he will not find it exemplified perfectly anywhere—in any industry, in any college or university, nor in his association with any technical society. Human beings are seldom capable of perfection in anything. The young engineer then needs to adjust his own thinking to the situation as he finds it and to try to improve the situation and himself within the framework which he finds. One thing is certain, a wholesome attitude in each new engineer in any laboratory is a force to the good. One candle in the dark can shed its light a great distance; so the new engineer is capable of being a strong influence in creating the right kind of atmosphere in places where it did not exist before his arrival.

Conclusion

In summary, the entire program of helping make the engineer's first five years in industry successful is a joint effort. I want to emphasize, however, that in the final analysis engineering education, technical societies, and industry can serve only to assist the young engineer in his own development—to point the way. The sole responsibility for assuming and developing right atti-

tudes toward work, toward people, and toward living—and thus developing a successful life—rests squarely on the shoulders of the young engineer. No agency or other person can do the job for him.

The young engineer will find that hard work on his part is the key to his success not only in his five years but in all his years to follow—and gentlemen, there is something dignified about hard work. If he needs assistance and is looking for a helping hand, let him first be sure to use the two that are hanging at his side.

This, in a nut shell, is what "Experience Tells Me."

Sections and Branches

The Fall Meeting of the **Middle Atlantic Section** of ASEE was held at the University of Pennsylvania on December 5, 1953.

The morning session was held in the University Museum Auditorium, and was opened by Chairman C. F. Bonilla. He introduced Dean C. Chambers of the Moore School, who, in turn, had the privilege to present Dr. G. P. Harnwell, President of the University of Pennsylvania, who welcomed the members and their guests. The speaker for this meeting was Dr. M. D. Whitaker, President of Lehigh University, whose subject was "Our Changing Problems." These problems include crowding, curriculum content for broad cultural training, lack of teachers, which is most noticeable in the elementary educational group at present, but which will reach the high school and the college groups in the near future. A solution to some of these problems, even in part, would go far to improve our educational system.

A business meeting followed the morning meeting. After the approval of the minutes of the Spring Meeting held at the University of Delaware, and the financial report, Chairman Bonilla received the report from the Nominating Committee, and, since there were no nominations from the floor, moved that the following be declared elected:

Professor H. M. Jenkins, Swarthmore College, Chairman

Mr. Forrest E. Allen, The International Nickel Co., Inc., Vice-Chairman

Dean Thorndike Saville, New York University, Section Repr. on Council, and Professor H. S. Bueche, University of Delaware, Secretary-Treasurer, had previously been elected.

The Chairman requested the Section to vote on a new By-Law, namely: At the election of officers in even numbered years, the Nominating Committee present the name or names of those to be voted in as Section Representative on the National Council. This office is for two years, and the person elected takes office ten days after the Summer Annual Meeting following his election. This By-Law was approved.

The Chairman appointed a committee consisting of William Allan, *Chairman,* D. J. Stanley Morehouse, and A. W. Luce, to study the Grinter Report. Since so many present had not seen or even heard of this report, it is hoped that a broad informative report may be made at the Lafayette College meeting.

The Section also approved prize awards for the winning papers in the Paper Contest for Young Engineering Teachers. These awards for 1954 will be $25.00, $15.00, and $10.00, and the papers will be eligible for the National Prizes of $200.00 and $100.00.

Seven group meetings were held in the afternoon, followed by a social hour at the Penn Sheraton Hotel. Dinner for over 150 was held in the same hotel, after which there was adjournment.

Summer Employment—Boeing Style

By HAROLD P. SKAMSER

Chairman of Engineering Placement, Michigan State College

and CLYDE E. WORK

Associate Professor of Mechanics, Rensselaer Polytechnic Institute

A lively interest seems to be developing in organized industrial employment of engineering faculty during the summer. This offers one promising answer to the need for closer cooperation between these two groups to cope with the complexities developing in modern industry and to facilitate the application of advances in science and technology in college and industry.

That employment of faculty members in industry is already widespread was indicated in a survey conducted last year by the Relations with Industry Division of the ASEE. Faculty members reported experience in industry on the following bases:

1. full time (previous to teaching)
2. part time (while teaching)
3. consulting
4. leave of absence
5. summer

A broad field of activities were included in the industrial groups listed as employers.

This article has been prepared to point out the considerable opportunities which summer employment of engineering faculty members offers especially to engineering education. Some of these advantages can be gained in other ways, some cannot. The inspiration for writing this article resulted from a summer spent by the authors in the Summer Faculty Program of the Boeing Airplane Company in Seattle.[1] The Boeing program and comments on it will be used as examples here,[2] because Boeing has combined the advantages of hiring faculty consultants and sporadic employment with those of "Seminar" summer indoctrination programs, so popular in the East.

Full Time Industrial Experience

Experience in industry on a regular full time basis previous to teaching or at intervals during the teaching career sounds highly worthwhile, but if considered alone has considerable practical limitations. If undertaken immediately after college the professional level of such experience is not likely to be high enough during the first few years to make an optimum contribution to later teaching. Impressions resulting are from a limited period in this type of job in only one company and would not be sufficiently broad. If the engineer progressed rapidly or worked long enough in the industry to attain a position of responsibility with experiences and a perspective of real value in teaching, the remuneration he would receive in industry reduces the chances of his being attracted to teaching.

[1] Professor Work was a Summer Faculty employee and Professor Skamser was the Coordinator for Boeing's (Seattle) Program in 1953.

[2] A second article will appear in next month's *Journal* describing some of the features in Faculty Employment Programs. Teachers' conferences and Seminars developed by other companies.

If his full time practical service should have been prior to his teaching career, the continuous advances in technology and commercial practices gradually reduce the applicability of early experiences to current and future situations. To repeat periodically, such service on a full time basis to keep up to date and to cover several areas of interest requires breaking continuity and is rather difficult to work out.

Part Time Employment

Part time practical work outside the teaching profession is limited to those geographically situated so as to be convenient to the industrial groups with which the professor is to work, to men in schools where policy permits and where private employers have part time assignments. This always represents a conflict of serving two masters. Usually the balance is too delicate to maintain and the interests of one are allowed to encroach on those of the other.

Consulting

Consulting work during vacations and other free time provides variety of experience of timely interest and application. However, these positions are not generally available to the ones who need the experience most, the young and inexperienced teachers. Experience limited to consulting tends to provide a somewhat distorted picture. To be called in as an expert in a particular phase of work to tell others what they did wrong or tell them how they might try to handle a problem is a far cry from the real situation of meeting daily problems and living with the situations which you develop.

Leaves of Absence

Leaves of absence cause enough breaks in the continuity of an academic program and for perhaps other reasons they are rare enough to offer only very limited help in this area and when given are less frequently available to junior members of the faculty.

Summer Opportunities

Examined in the same light, summer employment offers real promise:

1. It is available at all academic levels and for members of faculties of all schools.
2. It can be repeated periodically to give a broad perspective of different assignments, of different industries, different geographical areas, and up-to-date ideas brought back to the classroom.
3. It provides a real change from academic routine and responsibilities without interfering with continuity of scholastic programs.
4. The level of professional experience advances as the professor himself develops.

How much is gained from summer experience is determined by the positions available, the assignments given, the attitude of the professor and the attitude of the employer.

The Summer Job

The most common form of summer employment of faculty by industry involves hiring a specific man to work in a particular division of the industrial group on a specific job assignment during the period of his summer vacation. With the current need for engineering services there are large quantities and varieties of opportunities available on this basis. Even if the employer makes no effort to expose the temporary employee to more of the companies operations and problems than the specific job to which he is assigned, the professor can make a definite contribution to his employer and his summer's activities and contacts can contribute toward improving the effectiveness of his teaching.

The Industrial Conference

Another type of summer opportunity for college teachers offered by industrial groups is in the form of a conference or seminar program to which a group of educators are invited. An enlightening program of lectures, discussions and tours is presented at company expense to give those in academic positions a comprehensive picture of a rather broad scope of the activities, facilities, philosophy and problems of the host company. In the extreme form little if any return is expected of the educator beyond goodwill and his voluntary criticisms and suggestions.

The Boeing Plan

The program which has been developing at Boeing combines the advantages of both limiting cases. Participants are impressed by the evident sincerity and energy of those responsible, who continually revise the program to make it increasingly worth-while from the educators standpoint, while maintaining the productivity of summer employees to pay the bill.

Objectives: (1) *To accomplish significant work assignments.* With their large background of engineering commitments many items lend themselves to assignments of two or three months duration. Selection of summer faculty employees, is based primarily on the work assignments available each year. These extra man-hours are particularly timely in equalizing the work load when many permanent employees are on vacation.

(2) *To provide industrial experience for professors.*

Because of its nature, the aviation industry must be operated in a different manner from most other industries, extremely flexible, quickly adaptable to new ideas and constantly pioneering into the future. Because this industry is destined to continue as a major factor in industrial, economic and military future of our nation, it is important that professional teaching personnel be familiar with some of these concepts by direct association.

(3) *To provide mutually beneficial relationships with technical schools.* New engineering manpower for Boeing must, for the most part be obtained from the graduating classes of accredited technical colleges and universities. It is believed that training of this potential manpower can be greatly enhanced by the association of students with teachers who themselves have had direct contact with the Boeing organization.

Details of Program: From 50 to 75 full time faculty members, purposely selected to represent as many schools as possible (distributed geographically over the whole nation), are offered assignments for a minimum period of two months in the various units of the company's organization. Note: 72% of the 1953 group were under 41 years of age. 30% were instructors and assistant professors.

In 1953 the professors worked in the following areas: gas turbines, process units, metallurgy lab, personnel, salary administration, aerodynamics, stress, structural development, power plant, liaison, and electrical work for the C-97 stratocruiser, the B-52 heavy bomber projects, mechanical equipment, air systems, hydraulics, servo-mechanisms, acoustics, electronics, armament, physical research, Bomarc (guided missile) etc.

In order to cover as large a number of different faculty members as possible only a few repeaters are selected and then only when it appears particularly worth-while to continue a given project into a second summer.

Each summer-hire professor participates in the one day indoctrination program for regular new engineering employees to begin his familiarization with the company and to let him see, first hand, how permanent employees are indoctrinated. Those faculty members who are assigned to Project Groups, and require more familiarity with company standards and procedures of design and pro-

duction, participate in the regular two-week familiarization course before going to their assignments.

Seminars: One hour weekly is devoted to seminar meetings for summer faculty members and certain key Boeing personnel with the purpose of acquainting each faculty member with the broader aspects of the company.

Each summer the nature of the seminar programs has been varied to suit the interests of the visiting faculty members. However the first three programs each summer generally give a broad over-all picture of the company. The first is a general discussion of the company by a leader such as the Senior Vice-President. The second seminar is concerned with the manufacturing organization led by a top executive in Production Engineering. The third treats the Engineering Organization and is presented by the Chief Engineer.

Other seminar programs were planned and topics are selected by the participants themselves who, in 1953, chose subjects such as: the jet transport, guided missiles, analog computers and industry's evaluation of technical education.

Plant Tours: The more or less formalized tours of the Boeing facilities have evolved through the years into a plan for four half-day tours in 1953, each devoted to one of the four major areas. Guides and those planning the tours were exceptionally receptive to the desires of the participants and additional tours of areas of special interest were arranged upon request. Visiting professors are encouraged to visit any other areas of personal interest.

Faculty Coordinator: One feature made possible in as large a program as this was the selection of an engineering school placement officer for the job of direct leadership in the activities of the summer-hire professors. His duties were (a) to assist in detailed planning of the lectures and seminars, (b) to act as liaison between summer participants and the company and to assist in ensuring suitable technical assignments for all participants, (c) to assist in the detailed planning of such recreational activities as are developed, (d) to act as advisor in matters pertaining to "off the job" counsel and assistance and (e) surveying the faculty to assist in evaluating the program, etc.

Social and Group Activities: The summer faculty planning committee with the leadership of the coordinator arranged two major social functions, a family picnic and a chartered boat trip around the Seattle harbor and canals. The coordinator also represented the group, in planning with company officials the welcoming buffet supper, an afternoon program for wives, and a farewell dinner. The stimulation of warm personal friendships with other visitors through informal social and work orientation activities proves to be an extra feature of the summer.

A visit and tour of the University of Washington Engineering School was arranged with the cooperation of U. of W. faculty participants in the summer program. Visiting professors also became personally acquainted with the personnel in the units in which they worked and were invited to share their social activities during the summer. They were also given Honorary Supervisors Club cards.

Talks with Alumni: The summer offers opportunities for comparing notes on education and industry with former students, currently employed at Boeing. Through the coordinator's efforts, a directory of their alumni (employed by Boeing) was made available to the summer faculty group.

Housing: To take advantage of the superb geographical attractions of the area for combining vacation with work, the summer at Boeing is a family affair and participants are aided in arranging suitable quarters for the summer by the company housing division.

Compensation: Salary during the period at Boeing is based on the applicant's current teaching salary as computed on

a nine months basis. An allowance for travel from his place of residence to Seattle is also offered.

Conclusions

The outstanding success of the Boeing summer faculty program depends primarily on a mutual feeling of accomplishment. The short term results of the program to the company are very gratifying. Supervisors reports have indicated unquestionably that the program is an economic success—that the actual engineering work accomplished by faculty members had fully justified the cost of the program, exclusive of the intangible benefits. Faculty members, almost without exception, are enthusiastic in their belief that this type of program is superior to casual summer employment which they had previously experienced. In a winter survey, 93 per cent of the 1953 group indicated that their experience made a significant contribution to their teaching through practical illustrations, better understanding of the industrial position, broadening of viewpoint etc.

Justification for the Boeing Program and similar efforts in other companies can be summarized by the statement of one Boeing summer-hire professor, "No engineering professor can do a satisfactory job preparing students for their future work, unless his own experience has been periodically revitalized by working contact with industry."

College Notes

In response to a growing demand for increased part-time engineering training, Dr. John R. Dunning, dean of the **Columbia University** School of Engineering, has announced that a full undergraduate course of study leading to a B.S. degree in industrial and management engineering will be given at night, starting with the 1954–55 academic year. While the School of Engineering has been offering graduate work at night for several years, the industrial and management engineering curriculum is the first such program to be offered on an undergraduate level.

The annual **Cornell Summer Laboratory Course** in Techniques and Applications of the Electron Microscope will be given this summer from June 14 to June 26, 1954, by our Laboratory of Electron Microscopy in the Department of Engineering Physics. The course under the direction of Dr. Benjamin M. Siegel will have Dr. James Hillier of Melpar, Ind., Alexandria, Virginia, and Dr. C. E. Hall of M.I.T., Cambridge, Massachusetts, as guest lecturers this year.

The course is designed for those research workers, institutional and industrial, who have recently entered the field of electron microscopy or who are now planning to undertake research problems involving applications of this instrument. Further inquiries should be addressed to Dr. Benjamin M. Siegel, Department of Engineering Physics, Rockefeller Hall, Cornell University, Ithaca, New York.

General Observations on Cooperative Education*

A. At Aluminum Company of America, Alcoa, Tennesse

By JAMES W. HOYT, JR., *Works Personnel Manager*

Many of our top management executives, engineers and supervisors are products of the cooperative plan, an educational program under which college students alternate periods in school with periods in industry to get practical experience along the line they are studying. We have been using the co-op system at Alcoa since 1926 and the quality of personnel secured through this program has been very gratifying.

We all agree that it is necessary for engineers, and other professional people as well, to have practical experience after graduation before becoming proficient in their field. We consider an engineer who has co-oped with us to be at least two years ahead of the engineering graduate. Some of our junior executives who were among the first to come with us via the cooperative method, feel they acquired far more than two years' experience.

Before detailing the actual procedures of handling our cooperative program, I believe we should ascertain first the great difference that confronts a technical graduate of today, and some fifteen years ago. In bygone years a brilliant technical man could enter into industry and become quite successful because his ideas could be applied without question. Today that man is handicapped if he has not acquired executive and administrative abilities in the field of industrial relations. In our present modern setup, where labor unions have acquired great strength and overall changes have taken place in our concept of relationships with all groups, the chief engineer is required to use more and more human engineering along with his technical engineering ability in directing his department. His success depends to a large extent in getting along with people at all the various levels, from the operator of a machine to the works manager.

Now let us turn to our cooperative program as it works in our Alcoa plants. It has been our policy and practice to rotate each co-op student in various types of work, giving him training in all phases ef engineering and operating work. This method enables him to find out how these various departments function and how each is dependent upon the other, how they all, working together, form a team. Co-op students gain practical knowledge of our operations, and above all, they get the thinking, attitudes, etc., from the hourly workman as a co-worker that they can never acquire when they come into an industry as a graduate engineer working on the engineering staff or as a technical trainee in an operating department.

Rightfully or wrongfully, there is a stigma placed on any graduate who has never worked with hourly people when he comes in over them. I do not mean to intimate that all egnineering graduates who have not co-oped are doomed. I am merely accenting that a co-op has a distinct advantage in this field. There is a great deal of difference in the environment of a college campus

* Presented to the Cooperative Education Division of the American Society for Engineering Education, Gainesville, Florida, June 24, 1953.

and that found in most industries. The universities stress intellectual attainments and the problems are somewhat limited in scope. In industries, on the other hand, there is pressure, tension and demands for results. The cooperative method will tend to acquaint the student with the many problems that will confront him in later life in the engineering field.

We purposely assign co-op students to various types of work to find out how they will react under certain tasks and conditions. By this method we are able to judge the attitude, mental and physical make-up of the co-op. We collect the recommendations from the various departments in which a co-op works, and from these we make the final appraisal of him.

Upon checking records of our co-op students, who trained their entire period with us, only five are not with us today. Two of these are in the armed forces. Yes we are proud of this record and rightfully feel that we should be. It is our firm conviction that the Aluminum Company of America's policy is sound and that our relationships are fair and equitable. Therefore, when a co-op works with us through three or four years in the program we feel that he will want to come to Alcoa.

Another important phase from the Company's viewpoint in the cooperative program, is to take sufficient time to orient him into the organization. Usually this is the first time he has been away from home. He is among strangers and required to plan and make decisions with which he has never before been confronted. He must have a feeling of "belonging" and be made to realize he is part of the organization, whether it be large or small.

You who are university coordinators play a far greater part than the companies in the success of the cooperative program. You must be an adviser and counselor to these co-ops because they no doubt have many problems other than their studies with which they turn to you. In my opinion, industry in general should do more to fulfill its share of responsibility in making the cooperative program successful. We are hopeful that we have not been neglectful of our responsibility in the Tennessee Operations. I believe we have made a sincere and honest effort to carry the full responsibility which should be our just burden.

There are advantages to the co-op other than the means of obtaining an education, which he could not otherwise obtain because of monetary reasons. Every engineering student must at some time or another determine for himself whether or not he belongs in the engineering field. We have from time to time found boys who think they want to be engineers, but after a few quarters of school work and work periods, decide they do not like the engineering field. I remember one young man who co-oped with us for two years to find he was not interested in his selected engineering field. He told me he had wrestled with the decision for two quarters trying to make up his mind to change from engineering to the ministry. He had become interested in church work and found it more appealing than engineering. I knew he had another interest because his heart was not in his work. After telling me his story, I frankly advised him to change his course and give up his co-op work. Today this fine young man has been ordained and is making a success as a minister.

The co-op in turn has an opportunity to judge, appraise and pass final decision upon whether he would like to work for that industry. Furthermore, it gives him an opportunity to decide if the particular field he is studying in is the one in which he would like to cast his lot for life's endeavor. It has been our experience that several students through the cooperative program have decided to change their course of study and many of them have become success-

ful in other walks of life rather than working in industry.

At our Tennessee Operations in Alcoa, we instigated a new phase of the co-operative program, at least it is a new phase with us. No doubt other industries may have already entered into this field. This specific phase was to contact the various high school principals in the surrounding area to encourage their more likely students to enter into the co-op program. In our general personnel contacts we visit twelve or fifteen high schools in the spring of each year, so actually it was little trouble for us to enter this phase of cooperative solicitation, so to speak, along with our normal visits. Another method we use is to present to our Management Conference Program, which has an attendance of about four hundred twenty-five people, the co-operative program pointing out its advantages to people who probably otherwise could not or would not receive a university degree. These conferees in turn were encouraged to express the possibilities of the cooperative program in their communities and localities. We feel that in a few years this will bring beneficial results to industries and universities who are interested in the cooperative program. I would like to point out that in our visits to high schools, we would never acquiesce to employing any student where there is a possibility of his seeking higher education.

We at Alcoa realize that the cooperative method has come a long way since its inception. We fell it is better today than ever before. In other words, gentlemen, we like it and plan to continue the program at Alcoa, Tennessee.

B. At E. I. du Pont de Nemours & Company, Chattanooga Tennessee

By D. G. MACDONALD, *Personnel Supervisor*

Many of the citizens of the world are educated by experience only; others are well-trained in the theory. Co-op graduates have both. Perhaps my boss had a reason when co-ops were first talked of when he said "Can you prove that the program is worth the cost and trouble?" The last hurdle was cleared when we were able to establish jobs that were outside of the bargaining group of the union. The start of the program was slow and intentionally that way. This allowed us to work with co-op directors and design a work program that would accomplish our primary objective—to give the co-op graduate the best possible training for long-range responsibility in industry —we hope our own.

In our business we often find ourselves trying to establish objectives and working out a sound philosophy for doing a job. Our co-op program objectives have crystallized as follows:

1. Graduate Procurement
2. Improved Training
3. Vocational Guidance Assistance
4. Shorten Final Orientation Period.
5. Help Students obtain Education
6. School Relations.

On a Cooperative Student's first day at work, our Training Supervisor spends a lot of time showing the man around and introducing him to the Manager and his staff members. We help him find a place to live and give him a special booklet of hints that will help him feel at home and find his way around the plant and the community. For the first week the new co-op follows a schedule that will carry him to all areas of the plant and he is introduced and talks with many members

of supervision. He is never left alone during this first week.

In our plant, co-op engineers are placed in one of the following jobs depending on their course and expressed interest:

Works Engineering
Methods and Standards
Process and Development
Production

Our whole program is built on the premise of varying the work experience to broaden the student's knowledge and understanding. This can be illustrated by the schedule of a civil or mechanical co-op in our Works Engineering Section as follows:

Assignment	Work Period
Design	1
Maintenance	2
Project Construction	3
Power	4
Design +	5
Design + +	6
Design + + +	7
Design + + + +	8

In the above schedule the trainee is assign problems and work of an increasing complexity, and by work period No. 5 he will begin to develop experience and real productivity. If not capable of handling a job alone, he will work with an experienced engineer until experience develops. We endeavor to extend the individual's capacity and give responsibilities commensurate with ability.

The co-op is always responsible to one man only. This individual supervises his work and talks with him about his performance, and at the end of the quarter, makes a formal report for management and the college.

We, at the Chattanooga Nylon Plant, are enthusiastic over our co-ops.

Our Company follows a practice of financially recognizing the five-year co-op over the four-year B.S. All during the co-op work experience we also grant a $15 per month increase each work quarter.

We rely heavily on the assistance and cooperation of the college co-op coordinators. Their help is indispensable and we have evidence that the joint effort has been effective in correcting faults and weaknesses in individual cases. In my job no greater satisfaction can be realized than observing successful personnel development.

The Place of Advanced Degree Engineers in Industry*

By S. L. SCOTT

Personnel Division, E. I. du Pont de Nemours & Co.

No one who has been concerned with the recruitment and placement of technical graduates during the past year can be unaware of the current high, unprecedented demand for engineers of all levels of training, and certainly demand implies need. It does not follow necessarily, however, that this recognized demand and its implicit need signify a proportional—or higher—increase in the requirements for men with advanced training. Yet the last decade has shown an unmistakable trend toward increased utilization of engineers with graduate training. Although graduate work in engineering has not gained the status that has come to be accepted, for example, in chemistry, a glance at the numbers of degrees granted during selected years since 1938 provides ample evidence of its growth.

	1938–39	1939–40	1942–43	1946–47	1948–49	1950–51
Number of first degrees	12,408	11,358	14,145	18,592	41,793	41,893
M.S. and other predoctoral degrees	1,219	1,318	637	3,090	4,783	5,134
Doctor's degrees	97	108	87	127	417	586

Obviously there must have been some incentive for the attainment of this additional education. Granted that the G. I. Bill made it possible for greater numbers to attend college and to continue beyond the baccalaureate degree (in all disciplines; engineeering was not unique in this respect); granted that the schools themselves have tended to require that their staffs possess advanced degrees; and granted that our continuously expanding economy has provided employment for ever-increasing numbers of technically-trained men—even so, these opportunities would not suffice to stimulate graduate work to the extent that it has flourished. Furthermore, the number of individuals who seek advanced degrees for the degrees' own sake must be negligible; present-day economies do not foster the luxury of education for which there is no market.

No attempt will be made here to set forth all of the reasons for advanced work, but it cannot be denied that personal satisfaction must stand high on the list. The desire for knowledge is compelling to certain individuals, and intellectual curiosity is undeniably a prime requisite for success in any technical pursuit. Those so endowed are usually the ones who seek or are urged to attain the higher levels of training. The significance of this motivation must be all the more readily apparent today, when the availability of jobs furnishes such strong temptations to terminate education at all transition points.

Economic Advantages

To argue that higher financial reward is the sole and sufficient goal of addi-

* In this study, the author was assisted by B. R. Teare, L. R. Baker, Robert F. Moore, and T. K. Sherwood.

tional training is to ignore other, equally or perhaps more important, factors. On a purely practical basis, the economic advantages of a master's or doctor's degree are difficult to substantiate. Certainly engineers with advanced degrees *should* command higher starting salaries than their B.S. associates, and the fact that industry, government, and the universities have established differential rates provides further evidence of the need for graduate training. The opinion that doctors are hired for jobs which could be done as satisfactorily by bachelor or master engineers is not uncommon, especially in academic circles, and may have some justification, but the laboratory director who maintains that long experience has demonstrated (to him) that the doctor will do the job better is probably quite right. He, and hence industry in general, feels very strongly on this point, else he would not be willing to pay a premium for talent if he could hire its equivalent at a lower salary. No private organization can afford such extravagance in the face of today's competition.

Certainly it behooves any employer to make the most efficient use of his investments, whether they be machines, men, or money. Of these, the most critical are the men, and no one is harmed more than the man whose abilities are not challenged to the utmost. Industry has often been accused of diverting its advanced degree engineers into channels which do not utilize their specialized knowledges and techniques to their fullest capacity. Such accusations are not always groundless. But it should not be forgotten that people's interests change, that circumstances are never stagnant, and that it is not always easy to judge whether someone else is contributing his maximum productivity.

Monetary reward is probably "after the fact" as evidence of need for the advanced degree engineer in industry. The real reason is much more basic: growth of opportunity for his services. This opportunity lies in industry and government as well as in teaching, and mostly in industry, even though openings in government-sponsored installations have increased markedly since 1940. This is a natural partner of the growth of science and technology. Today any layman can cite any number of developments exemplifying that growth. It is indeed unfortunate that those which may be foremost in his mind may be associated with military objectives, and probably equally unfortunate that for every one of these there are many others—equally significant, and lacking the stigma of destructiveness—of which he is blissfully ignorant, but even that same layman cannot be unaware of the burgeoning complexity of technology.

For many years, fundamental research was regarded as the exclusive province of the colleges and universities (at least in this country). Perhaps it still should be. Certainly there can be no doubt that our academic institutions must continue to be our main source of basic truth and knowledge and that they must be encouraged in that respect to the utmost of our resources. But World War I demonstrated all too clearly the dependence of American industry upon European scientific achievement. Some forward-looking organizations were already aware of the value of research, of course, but the shortage of aspirin and dyestuffs—to pick two homely examples—was a very convincing argument.

Solidly Entrenched

Later economic developments have undoubtedly encouraged the trend. In any event, research appears to have become solidly entrenched as a proper activity of industry. Once established, its advantages were undeniable, and it flourished mightily. The more basic the industry, the more important it became, until today research is regarded as indispensable to survival, let alone progress. So intense has competition grown. The fact that government has entered the scene in a

wholesale manner does not alter the situation; it intensifies it.

If research in applied science is now an integral part of industrial endeavor, it is inevitable that more intense specialization in engineering lines should follow. For no matter how devoid of material gain a commercial organization may state the aims of its research to be, it is, and must be, in business to make a profit on its operations. No matter how long-range, or how theoretical, its scientific investigations, they must be paid for out of the earnings of that portion of research which resulted in a commodity which somebody wanted or needed.

The route between new knowledge in the laboratory and a new product on a retailer's shelf may be short and direct or it may be long and devious, but invariably the engineer's skill is required. The more basic the knowledge, ordinarily, the longer the route and the more the skill that is necessary. New products demand new techniques, new procedures, new materials in which to manufacture them, new designs—new everything, in many cases. And once a product is an article of commerce the factors of continual improvement appear. A procedure has to be "frozen" and standardized at some stage, but scientific and engineering research must go on. Obsolescence is inevitable. Even "old" products require constant surveillance; alternate routes, depletion of natural resources, further research, and a host of other reasons may start the cycle all over again.

The natural consequence of this situation (perhaps "snowball effect" is a more descriptive term) is increased emphasis on the more advanced and technical phases of engineering—the phases which have come to be known as design, development, and research. It will seem trite to say that the place in industry for engineers with advanced degrees is in these very phases, particularly during the early stages of their careers. The conclusion is too obvious, even though it is generally conceded that engineers seek training beyond the baccalaureate level in order that they may satisfy a desire to participate in those phases. But the conclusion is none the less true.

Questionnaires

Lest this might appear too arbitrary a deduction, two questionnaires were prepared. The first was submitted to those institutions whose engineering curricula are accredited by ECPD; the second was sent to a number of industrial organizations whose products or services were deemed to require a high level of engineering skill. Generally speaking, the replies to these questionnaires supported the above conclusion.

For example, the concensus of 91 replies from the 115 schools to which the questionnaire was sent was that there was an increased demand in industry for advanced degrees, and that individuals holding these degrees generally go into research, development, and design, in that order. Those institutions which grant Doctors degrees indicated overwhelmingly that the Doctor is more sought after than the Bachelor as far as the greatest number of desirable job offers is concerned.

The Employers' Questionnaire was submitted to a wide variety of organizations: aircraft, air lines, automotive, electrical, heavy equipment and machinery, petroleum, pharmaceutical, railroads, and a few which are popularly called "engineering" firms. Of 133 companies solicited for information, 112 replied.

Marked gains in the employment of advanced degree engineers were reported by the 57 companies which were able to provide data for 1940 and 1952. During that 12-year period, B.S. employment increased 147%; M.S. 208%; Ph.D. 175%. These gains are even more striking if the data are limited to those organizations employing (in 1952) more than 10 Ph.D.s; the increases were then 152% for B.S. degree holders, 219% for M.S. men, and 222% for Ph.D.s.

That the companies which hire the advanced degree men have found the practice rewarding is demonstrated by the fact that 65% of them indicated that their current trend is to hire proportionately more M.S. and Ph.D. engineers than B.S. men.

The data on how advanced degree engineers are used are especially interesting:

	Initially	After 5–10 years
	(% of replies)	
Administration	2.8	20.5
Design	22.0	15.7
Development	25.2	17.7
Production	15.1	12.2
Research	24.8	19.7
Sales	6.0	9.1
Other (unspecified)	4.1	5.1

These figures indicate that the great majority of the advanced degree people remain in the more highly technical types of work. Interestingly enough, 80% of the replies stated that these men do *not* have a better chance of getting into administrative work than the Bachelor—with the possible exception of *research* administration.

Remarkable Parallelism

Both questionnaires requested general observations of the place in industry of engineers with advanced degrees and of the trend of their industrial employment, and there was a remarkable parallelism between the replies from the companies and those from the schools. Research and development were invariably mentioned as the proper niches for engineers with advanced degrees, with design a strong third. It is significant that production, which ranked fourth on a statistical basis, was rarely mentioned in the comments as an opportunity for the individual with graduate training. This may be due to an idiosyncrasy of classification: technical employees in plants are often listed as production workers—for budget purposes, if for no other reason—even though they are actually engaged in activities which under any other circumstances would be designated as development. This practice is not universal, of course, but it is nevertheless widespread.

With respect to the trend, the concensus was that the need for advanced training is on the increase. Even organizations which do not hire such individuals thought that to be the case. One comment in particular appears to summarize the situation: "With the rapid advance and progress of science, it is becoming increasingly difficult to do more than scratch the surface in most engineering fields in the normal 4- or 5-year engineering curriculum. Advanced work is, therefore, becoming necessary and even mandatory, especially in research and development."

The author wishes to acknowledge the assistance of L. R. Baker, Robert F. Moore and T. K. Sherwood in the preparation of the questionnaires mentioned above and in approving the final report.

Grease Monkeys or Citizens?*

By DR. EDWIN S. BURDELL

President, The Cooper Union, New York, N. Y.

I have long wanted to pay tribute to the teachers and administrators who have contributed to the development of the technical institute. Having been engaged in professional education of one kind or another since about 1928, I would venture express the opinion that the technical institute is the largest single innovation in our American educational system in the last twenty-five years. The great development of American high schools, which began another quarter of a century earlier, has had a tremendous impact on American culture, but at the post-high school level the technical institute as part of the junior college movement has been most intriguing to me and, while I have been only on the outer fringes of it, I have watched it with great interest. I was fortunate enough to have served on several committees of SPEE with Harry Hammond, while he was Dean of the Engineering School at Penn State. I served on the commissions that produced the 1940 and the 1944 reports. As you know, in the 1944 report there was a section devoted to the importance of the technical institute. That evolved from many thoughtful discussions by the members of that commission. We all felt that Dean Hammond was doing a great service to American engineering and industry by bringing the technical institutes into the fold, and we wanted to get behind him to support him.

Lack of accreditation up to 1946 was somewhat of a handicap in securing government grants during the war years, but that is all behind you now. The twenty-two of your sixty-four institutions that are now under the wing of the same accrediting council that certifies the engineering schools deserve congratulations. There are many limitations to accreditation and there are a lot of people who are setting up quite a fuss about it. Perhaps it has gone too far. Certainly, in the great state universities where there are seventy-five to a hundred separate agencies coming in, accreditation has reached burdensome proportions. But the educational principle of having some annual or biennial evaluation by an independent group of professional people is a matter that no college faculty should resent. It is very easy to get annoyed at filling out forms and bored at entertaining "visiting firemen" who come to inspect what you are doing, but taking serious objections to it is a short-sighted point of view for professional people. We need to have a mirror held up to ourselves occasionally and the fact that the technical institute existed for many years without any such self-evaluation does not justify that it should hold out against a general trend in American education.

Impact of Technological Advances

I would like to turn now to something that is probably as obvious to you as to me: the inevitability of the development of the technical institute due to the impact of the technological advances brought about by World War II. I have never ceased to be amazed at the fact that great constructive advances of mankind seem to be so closely associated with the de-

*An Address at the Annual Dinner of the Technical Institutes Division of the ASEE, Gainesville, Florida, June 23, 1953.

structive activities of man. Certainly science, the medical arts, and industry have gone ahead by leaps and bounds through the impact of war. So, however much I as a sociologist and as a humanist deplore it, I have to recognize the paradox and give the devil his due. For instance, the enormous training program that was necessary to operate the mechanisms associated with the mechanical end of flying required 2,000,000 skilled and semi-skilled technicians. Not only in war production, but in postwar production, the replacement of the individual craftsman by automatic machinery, automation, and servomechanisms has required a whole new category of the non-professional personnel to operate them.

Associated with this impact of postwar development is the scarcity of professional engineers and I would like to say a word or two about that. We are engaged in the production of engineering talent at The Cooper Union, where we are terribly concerned about the loss of teachers to industry. It's a good deal like the Biblical warning about not "eating the seed corn." How in the world can industry expect to have properly educated and trained professional people if industry persists in hiring away our teachers? I am glad to see that some industries are beginning to be concerned about it. The practice even affects our undergraduates. The seniors who have the prospect of choosing from among a dozen jobs at $350 or $400 a month let down their efforts in their senior year. Why worry? A sheepskin from old Siwash is all that's necessary. It even affects the junior year students who see their seniors flying off to weekends on the golf links in North Carolina—with, of course, the stated objective being the inspection of a cotton or dyestuff plant somewhere in the Tennessee Valley. The entertainment features, the disturbing factors of many industrial recruitment officers on the campus, have had a demoralizing impact on engineering education in the last few years. Now, I don't want to be misunderstood and say that I object to having our students being offered many jobs at good salaries, but you know perfectly well they aren't worth $400 a month and we know they aren't worth it, and if this delightful balloon on which we are riding happens to deflate, there are going to be some pretty dissatisfied and frustrated young men.

Low Utilization of Engineering Talent

I think also that industry hasn't been fair when it has stockpiled a good deal of the engineering talent that we do produce. There is a low utilization of engineering talent. We are told by some of our young graduates that they sit around and simply mark time. I made such a comment to the personnel directors in Pittsburgh some time ago and instead of being denounced there was a good deal of pointing accusing fingers not, of course, at themselves but at the fellow in the next seat whose company was stockpiling engineering talent waiting for that pot of gold at the end of the rainbow—that aviation contract that *might* come when they *might* need fifty engineers when actually they could get along with twenty-five. I understand also that it has caused a good deal of dissatisfaction among the older men who find themselves in competition with these youngsters and, with more or less fixed salary limits, it means that they have to go to job-jumping in order to gain salary increases.

All of this comes back to the fact that we need to produce more technical institute graduates. We need to produce more engineers, of course, but this is a group interested in technical institute education and training.

Thus, from a philosophical as well as a practical standpoint, you are greatly needed. The well-publicized shortage of professional engineers makes a tremendous demand on you people to increase your output. There is a recognized need for the "in-between" group—between the craftsman who will never go beyond using his hands, however skillfully, and the man

with the intellectual capacity to design and do other professional work. So you have a groove of very precise dimensions. I've talked to Director Klitgord and his associates over at the New York City Community College of Applied Arts and Sciences and I know that they are very conscientious not to take on youngsters or keep youngsters who are equipped mentally for professional engineering careers. The Cooper Union, being free-tuition, is the logical place for him to send some of those men. On the other hand, we have two to three thousand applicants each year and the vast number of those are not equipped for professional education. We return the compliment by suggesting a technical institute for some of those. As to numbers, for the last year that I have figures, the technical institutes graduated only about eighty-six hundred students from technical courses during the same year when forty-two thousand engineers were graduated. What a complete reversal of what the situation should be! If you take the modest ratio of three to one, the technical institutes should have graduated in that same year a hundred and twenty thousand instead of eighty-six hundred.

Broader Objectives

I would now like to come to the crux of my paper and to assert that in my opinion there is a need for acceptance of broader objectives of technical institute training. Present-day living requires preparation for life as well as for earning a living. To be sure, that sounds pretty trite, but that is the title of my paper —"Grease Monkeys or Citizens?" You have to raise your sights. The demands of modern society indicate that you must. There must be a motivation for participation in our democratic society and it is just as much an obligation on the parts of the educators and the technical institutes to take that on as it is to train them in the technology of the particular specialty. You simply can't take for granted today that our young citizens are going to find their way around in human relations in the shop, in the community, and the home; that they are going to be familiar with the helpful modern concepts of family life; or in citizenship matters that they are going to make intelligent choices of candidates for office; that they can exercise good judgment in accepting or rejecting proposals for community improvements especially in matters of public schools or in matters affecting our fundamental political organization, constitutional changes, and so on. Nor can you be sure that they can discriminate between good or bad leadership in their trade unions and in their social organizations; or be able to cope with situations that involve racial and religious difficulties. I'm sure that you will agree that there are areas of tension in American communities that are definitely slowing up industry and the good society because people are not familiar with present-day methods of coping with some of these racial and religious difficulties.

In other words, we must develop in these young men, whether or not they are of sub-professional level or professional level, a sustaining interest in the common welfare and in the cultural aspects of community life. There are no class distinctions in the matter of the enjoyment of the good life. There is no reason why the man in the three or four thousand dollars a year bracket should not be entitled to enjoy and benefit by the knowledge of good music, of artistic expression, and the development of his personality through adult education programs. He is just as much entitled and perhaps has just as much to contribute as the chap who is at a professional level. And I'd like to again interject my institution and its background by quoting from Peter Cooper, a remarkable man, who had tremendous insight for an industrialist in the mid-nineteenth century. In our Deed of Trust he provides: "that courses of instruction on social and political science, hereinafter provided for, shall have the preference over all the

other objects of expenditure specified herein, in case there shall not be means adequate for them all, and shall forever stand pre-eminent among them."

What was Peter Cooper saying? He was saying that his institution was not to turn out grease monkeys. He was saying that it was going to turn out citizens —people who, above all, had a background in social science, politics, and science and, therefore, would have a better understanding of the conflicts that were growing in the mid-nineteenth century on the eastern seaboard of America. And he went further to define social and political science: "Not merely the science of political economy but the science and philosophy of the just and equitable form of government based upon the great fundamental law that nations and men should do unto each other as they would be done by." In other words, he was injecting the element of values, which I must confess as a social scientist we have too often sidestepped. We winnow the census volumes for statistics and coefficients of correlation, but we shy away from making value judgments and Peter Cooper wanted to provide against that common failing so far as his teachers were concerned.

Difficulties

Well, you say, yes, sure, that's a good idea, but what are the "bugs" in it? What are the difficulties that you are going to encounter if you try to broaden and deepen the curriculum of the technical institute student?

I hope that if I have any contribution to make to this group it is in terms of experience. Dean Hammond, as chairman of the committee that I referred to, influenced the Society of Engineering Education to set up a Division of Humanistic-Social Studies. I was fortunate enough to be selected as the first chairman of that Division and served for four or five years. My trustees thoughtfully provided me with an administrative assistant to cope with the vast amount of correspondence and visitations that that report of 1944 stimulated. We gained quite a lot of experience in the implementation of the humanistic-social stem in engineering education, and I would venture to say that the problems that we encountered are pretty much the kinds of problems that you will find if and when you get into this field.

Our first difficulty was a matter of teaching personnel. It is obvious that the inspired young Ph.D. instructor is usually more interested in the minutia of his researches than in broad generalizations and stimulating the interest and enthusiam of freshman, sophomore, or junior engineers. However well prepared the professional teachers of English and social sciences may be, their own personal interests are not always toward this kind of "service" teaching. The ASEE very properly sponsored a number of summer institutes following its annual meetings and they successfully created an atmosphere of enthusiasm on the part of these young teachers and made it possible to exchange ideas and techniques of teaching.

Then we found that on the larger campuses it was very difficult to get separate departments of English, history, economics, philosophy, and sociology to work together on a coordinate program. The engineering dean had to go around and ring doorbells and he usually became pretty discouraged. The letters and correspondence we received revealed rather startlingly the cold shoulder that he received from the other deans and heads of departments. We advised the engineering dean to go to the president of the university and put it up to the president if it was beyond his scope to get the cooperation he was entitled to. We felt it was up to the president or one of his administrative officers to see to it that the dean got the proper cooperation. It was rather paradoxical that the engineering colleges that stand alone were in a good deal better position to control the teaching of the humanities than the larger universities that actually had much greater

academic resources. It is a sad commentary on the ability of educated people and scholars to work together but that was found to be one of our most common difficulties.

Tool Courses

We found that an approach by tool courses assisted in the acceptance of enriching the engineering curricula in these areas. In other words, to start in with English composition and public speaking and to teach them from the broadest possible point of view was a good way to begin. But it was found by the same token that some resourceful deans of engineering would tend to call almost anything "humanistic-social studies." Athletics, orientation, and even summer surveying camp were mislabeled or at least mis-classified in order to reach the recommended goal of 20% of the engineering curriculum to be devoted to this area.

And then we found that a number of engineering deans would say, "Well, we don't just want economics taught or English taught; we want English for engineers; we want economics for engineers." I suppose some of them might really look for music and art for engineers. We were completely and fundamentally opposed to that. If there is any validity to the field of economics, it is economics. The economic process and the economic institutions are fundamental. There isn't any more a brand of engineering economics than there is a brand of engineering algebra. It's economics; it's algebra.

Another difficulty was the demand on the part of some deans for a tailor-made program. Perhaps they had met some lack of cooperation and rebuff the first time they tried to organize a curriculum and they would write us at Cooper Union and say, "Now won't you just give us what seems to be a good well-balanced program and we'll take it to the president, and then it will be up to him to put it through." Of course, you can't organize an educational program that way. You have to set it up in terms of the campus resources in personnel, library facilities, and all the rest of it.

And finally the initial resistance that you will find on the parts of the students was startling. You may have won over the faculty, budget-wise and every other way, and your problems seem pretty well solved. Then, all of a sudden, you discover that the students will have none of it. That's exactly what I found in 1939, the year that I organized the Department of Humanities at The Cooper Union.

Let me tell you a little story to illustrate this point. We had a senior that year who was the top man in the electrical engineering course. He was so indignant about having to take a course in Social Philosophy that he not only went to the head of the department and to the dean but he came to me. "What a waste of time!" he said. Three hard long years to get up to the senior year in which he hoped to study everything that we had to offer in the field of electrical communications and now we were going to make him waste three hours a week studying Social Philosophy! Well, we argued with him, we cajoled him, and finally we compelled him to take the course. The end to that story was as follows: being the brightest boy in the class, he was also the valedictorian. What did he take for his valedictory address? A subject on electronics? No! He picked "Utopias." And why did he pick Utopias? Because he said he was so intrigued with his course in Social Philosophy and at man's efforts to draw blueprints for a better society that he wanted to share with his classmates and his friends in the audience the excitement and the inspiration that he had received over that course in Social Philosophy.

You *can* win them over, and you *have* to win them over if your program is to be effective.

What To Do About It

Now, finally, how and what to do about it. I've indicated that the teaching staff must be won over to the general program.

Then, of course, they are going to say, "Well, but the jug is full; how are you going to find the time?" It's true, the jug is full, and I'll suggest how to find the time. You will have to re-examine and rethink the validity of each subject in your curriculum. You'll have to decide whether or not that course in drawing really requires twenty-three plates or whether, by better teaching, you can give them just as much skill and practice by doing thirteen plates. We did that at Cooper Union. We doubled the number of instructors and we halved the number of drawing plates. It can be done if you have a courageous and inspired faculty that is willing to improve its teaching. I understand from Holderman's article in the April 1952 *Technical Institute News* that fifty per cent of your teachers are college graduates. There is no magic, I believe, in the college degree, but I think the better the education, the better the background your teachers have, the more ready they will be to take on experimental programs, and that is certainly true in the field of the humanistic-social studies.

We believe at The Cooper Union, a professional school devoted entirely to professional work, that the extracurricular activities and student government are very important and that much of what I am recommending can be achieved outside the classroom; in fact, a good deal can't possibly be taught in the classroom. It can only be done in terms of an inspired group of teachers who are willing to give their time to the students and provide continuity to the avocations and outside activities. Finally, on the organizational end of it, I recommend that a department of instruction for the humanistic-social studies be organized. I find in looking through the catalogs of a number of technical institutes that while there are many scattered offerings there is not much evidence of a departmental organization and inspiration or leadership.

Tremendous Challenge

As I have said, the jug is full, but let me point out that the jug rests on a great big saucer and this great saucer that can take the spillover for this new injection of material is the years following graduation. The motivation of students to continue their avocational interests will be a by-product of what I am urging and if it is successful they will want to carry on after graduation. Of course, you will want to be sure that industry recognizes the value of the graduate of the technical institute.

Your public relations programs should be stepped up as far as I can see in all of your communities. I think the American public has been over-sold on the value of the bachelor's degree and I am glad to see that the "degree" of associate in arts, the associate in science, as well as the general validity of the junior college program in general, are being recognized. It is a most hopeful thing in our American scene.

I think you should encourage your local public school systems to establish more of these institutes. They need to be expanded, or perhaps they need to be established. Finally, I suggest that you appoint a committee to study the problem as the engineers did in 1940 and 1944.

You have a tremendous challenge ahead of you. You alone can decide whether or not you will be turning out grease monkeys or citizens during the fateful second half of the 20th century.

National and Regional Developments in Cooperative Evaluation and Accrediting Activity*

By EWALD B. NYQUIST

Chairman, Middle States Association of Colleges and Secondary Schools, Commission on Institutions of Higher Education

I am not unmindful this morning of that rare occurrence which a general educator experiences when he secures as a captive audience not only a group as large and as promising as this one, but one which represents a single profession.

I have been asked to present to you a summary of the current status and activities of the National Commission on Accrediting, the present status and activities of the Middle States Association, and its collaborative relationships with the Engineering Council for Professional Development.

Status and Activities of the National Commission

First of all, let me define the National Commission. Seven national educational agencies, like the Asocition of American Colleges and the Association of Urban Universities, contribute six members each, all college and university presidents. It is supported by a membership of some 1200 higher institutions. Although its history goes back a long time, the National Commission was really born as such in 1949.

Its predecessors and the National Commission were concerned primarily with what they regarded as the evils of accrediting and first debated the issue of whether there should be any accrediting activity at all, but that matter was soon settled. The National Commission arrived at certain principles which it considered would conserve the values and abolish the evils of accrediting.

I think these principles can best be summarized in the time available by presenting the policy statements contained in a progress report sent by the National Commission to its membership as of September 4. I have included some others it had established previously.

1. Improvement of higher education in all of its parts is best achieved when based upon thorough self-evaluation prior to examination by outside specialists.

2. Institution-wide aims, objectives and responsibilities should be given primary concern and evaluations should be concerned with the institution as a whole as well as with its various segments.

3. Colleges and universities through the six regional accrediting associations should be the responsible and supervising authority for evaluation of higher educational institutions.

4. Channels through which the counsel and suggestions of the professions and employers of graduates can continually reach the institution should be maintained.

5. Accreditation costs and the number of visitations should be kept at a minimum. For accrediting purposes, not

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more than one organization should represent a field of training.

6. An acceptable program of accreditation should be fostered on a nation-wide basis.

7. Accreditation should exist primarily as a stimulus to institutional growth and development rather than be merely a standardization based upon minimum criteria.

The over-all objectives of the National Commission, I think, have been regarded as laudable by almost all accrediting agencies, regional or professional. I should like to emphasize the word, "over-all." In an attempt to consummate these objectives, however, the National Commission was at first imperfect in approach. For instance, after declaring a moratorium in accrediting activity, by January 1, 1954 it wanted all higher institutions to cease paying dues and accrediting fees to professional accrediting agencies, and, furthermore, all regional accrediting agencies were supposed, by that date, to be responsible for all accrediting.

Communications on specific matters from the National Commission were often confusing, sometimes unrealistic, and not infrequently illustrated the practice of the adoption in advance of arbitrary positions. At any rate, the initial activity of the National Commission touched off a first-class national ferment in education.

I am sure that the National Commission has certain important accomplishments to its credit:

1) It has stimulated all accrediting agencies to examine their purposes and objectives.

2) It has certainly reduced abuses in accrediting.

3) It has contained accreditation and confined it to certain limits and agencies.

4) It has provided accrediting at large with a definite purpose and objectives which accrediting did not have before.

5) It has in effect, provided a firm basis for national development and improvement of accrediting activity.

Last July, I attended a meeting of the Executive Committee of the National Commission. I am quite sure that the National Commission intends to pursue its overall objectives in a spirit and form different from those which characterized its earlier efforts. More realistic proposals will be made; the cooperation of all groups whose interests are at stake will be more solicited than demanded.

Status and Activities of the Middle States Association

I turn now to the Middle States Association and its Commission on Institutions of Higher Education, of which I am Secretary.

The Middle States Association is one of six regional accrediting agencies. Its area of activity, geographically, includes the States of New York, New Jersey, Pennsylvania, Maryland and Delaware, the District of Columbia, Puerto Rico, and the Canal Zone. It has existed since 1887. There are about 221 member institutions. Any higher institution is eligible, college, university, junior college, specialized, technical, or professional, so long as it has a program, at least 2 years in length, if at the undergraduate level, or of one year, if at the graduate level.

Our Commission is composed of 15 educators, mostly presidents, but of varying positions in colleges and universities and of diversified backgrounds. We have a central office and a full-time paid assistant.

First of all, I should like to cite some principles which control the organization and operation of our Commission.

The Middle States Association

1. Considers and helps every institution within its purview.

2. Gives proportionately the same consideration to large institutions that it gives to small ones.

3. Considers all programs within institutions in their relation to the institution as a whole.

4. Adjusts its standards in terms of a cross-section of the accredited institutions within its purview rather than in terms of marginal institutions or in terms of the highest ranking ones.

5. Enlists the largest possible number of participants in its membership of colleges and universities.

6. Operates with minimum paper work and minimum cost.

7. Provides for constant criticism, review, and readjustment of its criteria and its procedures.

8. Examines an institution in terms of how well it consummates its purposes and objectives. It has no matrix to press upon an institution.

9. Provides for growth through the stimulus of self-evaluation.

10. Employs qualitative criteria.

11. Is essentialy under the control of the institutions launching and supporting the program.

12. Treats institutions and their staffs with the dignity they warrant and honors their essential freedom and autonomy.

Relationships of Middle States Association with Professional Agencies

Now let me provide you with a little insight into our detailed procedures of evaluation and accreditation. At the same time I will stress those features which represent cooperation between ECPD and the Middle States Association. I might point out that our Commission has met with representatives from 26 professional accrediting agencies representing 22 distinct fields of interest. We have agreements with each of them along the lines of the one now in effect between ECPD and the Middle States Association.

1. Institutions being evaluated in any one year are those which are non-member institutions seeking initial accreditation and member institutions re-evaluated every ten years under normal circumstances. Simply organized institutions are evaluated in February or March in any one year. Complex institutions are evaluated in the fall. Initial arrangements for joint evaluations are made by the Middle States Association. Our schedule for evaluations is known for some years ahead for two reasons: Collaboration with professional agencies requires it and the institution must conduct a self-evaluation.

2. Questionnaires to be filled out by the institution are sent in advance of the visitation. Part A of this Questionnaire calls for data of common interest to the ECPD and the MSA and is answered once for the whole institution. Part B of the Questionnaire has been worked out jointly with ECPD and deals with the Program, Outcomes, and special problems of a particular unit in a complex institution and is to be answered only by the unit concerned. We have as many forms of Part B as there are areas of specialized and professional interest. In an institution with a single program, like liberal arts, the institution answers Part A and our own form of Part B.

Every member of the visiting committee receives, in cases of complex institutions, a copy of the university report, Part A, and those evaluators concerned with instructional units, like a School of Engineering, receive a copy of the report pertaining to that unit, Part B.

3. Every two years we ask member institutions to submit nominations of volunteer evaluators for use by our Commission in forming evaluation committees. About 1200 nominations are received and include every kind of person as far as position and background is concerned. Letters are sent to about 600 of these nominations to see if they will in fact be available in the near future. About 300 to 400 of these 600 are actually used by us.

4. Chairmen of the committees include all Commission members and an appropriate number of others drawn from those people who have served the Commission well in the past. The Committees include at least a majority of experienced evaluators.

5. The Committees used number no less

than 5 for any type of institution and may number up to 40 or 50 depending upon the complexity of the institution. Our Committees, in representation, reflect the organization and teaching functions of the institution being visited. For simple institutions, besides the Chairman, there will be one expert in Finance, one in Library, one in Program, and one in Organization. In complex institutions, having professional instructional units, expert personnel are added for each professional unit within the institution. In addition, in large institutions, we will add experienced people in areas like student personnel, admissions and records, intercollegiate athletics, and the like. Finally, on each Committee is a representative from the State Education Department in the State in which the institution is located which is done to eliminate the duplicate legal activity of the State.

When we evaluate an institution with an engineering unit, we request ECPD to furnish the expert personnel required. They represent ECPD as well as the Middle States Association and are integral members of the committees on which they serve, with the same responsibility toward the MSA as the other members and such special responsibilities toward ECPD as ECPD may direct. Usually this responsibility is the same one exercised by ECPD evaluators when the cooperative agreement now in effect did not exist.

6. Instructional materials are supplied all evaluators in advance. The Chairman also coaches his team. All members serve for nothing except the Chairman who receives a small honorarium. Committee members are reimbursed for their expenses which are billed finally to the institution. There are various financial arrangements with the professional agencies, including ECPD; in any case, one bill goes from the MSA to the institution and where formerly professional agencies did not charge for their independent visits, we do not, under present cooperative agreements.

7. The visit is made on a date convenient to everyone and the institution and lasts from 2 to 4 days.

8. During the evaluation, conference and discussion within the committee are emphasized. Each one has a particular assignment but each also has a voice in and a responsibility for the MSA report as a whole.

9. The report is prepared by the members are supplemented by sections on Purposes and Objectives and Outcomes prepared by the Chairman. Members representing ECPD write their reports analyzing engineering curriculums in their usual manner and these reports are included within the total institutional report.

10. Our commission meets twice a year and considers the original Questionnaire material, the report of the Committee, and an oral presentation of the Chairman.

11. a) The decision on the institution is then made. Certain substantive actions can be modified by procedural modifications calling for reports of progress to be submitted at certain dates by the institutions concerned or for subsequent modified visitations, usually informal for the purpose of observing at first-hand improvements made in weak areas.

b) Our Commission's decision to accredit an institution applies to the whole institution including its constituent units. The balance of factors in the institution's favor determines its accreditation. Therefore, an institution can be accredited as a whole even though some of its constituent units may be weak. On the other hand the Commission does not hesitate to deny accreditation to an institution in instances where specific weaknesses are evidenced in any programs, professional or otherwise, or in intercollegiate athletics, such that the educational effectiveness of the institution as a whole or its institutional integrity has not been demonstrated.

c) In instances where the institution is accredited as a whole even though there are weak constituent units our Commission expects within a certain time period

that such substandard programs will be improved and their weaknesses corrected. Failure to do so constitutes cause for denial of continued accreditation.

12. The institution may appeal from any decision of the Commission to the Executive Committee of the whole Association.

13. Personnel used on Committees are rated by the Chairmen. Those who are only fair or unsatisfactory are never used again.

14. All members of the committee, including the professional representatives, as well as the institution, receive copies of the final report.

Evaluation Process

I would like to summarize, for your benefit, the main points of the evaluation process of the Middle States Association where they are affected by virtue of the cooperative agreement made with ECPD.

1. We have agreed to exchange confidential information about institutions of mutual concern when such an exchange will strengthen the evaluation procedures of each agency and of course the institution concerned.

2. ECPD has agreed to designate for inclusion on our evaluation committees, evaluators who will represent both the MSA and ECPD.

3. We have agreed that reports of ECPD evaluators will be included in our total reports.

4. We have agreed on a joint Questionnaire, Part B which will be given a trial period this year.

5. We have agreed to exchange projected evaluation schedules for the purpose of attempting to collaborate in overall evaluations, as frequently as commitments of each agency permit, particularly in this transition period.

6. We have agreed to centralize the billing of an institution for the costs involved in order to reduce confusion and inconvenience for the institution concerned.

7. We have agreed that ECPD, in evaluating under these arrangements those curricula which are subject to its re-inspection or for which an institution voluntarily asks ECPD's accreditation, will also evaluate remaining areas in the field of engineering in order to give the MSA report a meaningful coherence.

8. Aside from these specific agreements, generally, I believe it is the intention of both agencies to collaborate in every way possible. The entire agreement is experimental for both sides for one year, after which the whole codification will be re-appraised.

The benefits to be derived from our cooperative arrangements would seem to be a better knowledge and understanding of the institution as a whole by all concerned; a reduction in duplicative activities and overlapping costs; a lessening to some degree in the movement toward entrenched departmentalism; and an appraisal of the institution and its various parts made available to it in the final report developed on a joint basis.

The MSA cherishes the cooperative agreement reached with ECPD, and all the more so because it was the first complete agreement reached and consummated by joint visitation between the MSA and any of the 26 professional agencies we are working with. A comity of relationships based on mutual respect and confidence is being established between ECPD and our Association.

Every detail of our plan will not always work out completely satisfactorily. Yet we believe that further common experience will lead to clearer insight, and that there are no insuperable problems in the type of cooperation projected.

Necessary for the Country

The plan for this type of cooperation is envisaged by the National Commission to be necessary for the country and not just the MSA. The other regional associations are not as far advanced as the

MSA is in this type of approach. You will, as a national professional agency of specialized and professional interests, encounter some problems in the future. I hope I do not convey to you an impression that the MSA is claiming a monopoly on wisdom and virtue in having proposed the broad outlines of the agreement now reached with ECPD. I mention the suggested difficulties because I realize in working with you your national interests.

Finally, let me give you the viewpoint of the MSA concerning its plan for and philosophy of evaluation and as they relate to professional agencies and the National Commission on Accrediting.

The MSA and its Commission on Institutions of Higher Education are the creatures of, and are in every respect responsible to, the member institutions of the MSA. Our Commission is not concerned whether specialized agencies publish their own accredited lists, and in so doing, maintain their own integrity as accrediting agencies of specialized interests. This question is outside of our Commission's province. It has no authority either to permit or to prohibit their doing so. It has no authority or mandate from its membership to absorb the functions of other organizations. It does not claim exclusive jurisdiction concerning accreditation in its territory.

Single Mission

Our Commission on Institutions of Higher Education has as its single mission the fostering and improvement of the quality of higher education in the Middle States area. Since evaluation and accrediting of institutions are among the Commission's means to that end, the MSA is interested only in improving and strengthening evaluation procedures when it seeks cooperative agreements with agencies of specialized interests.

Our Commission does not establish or enforce the requirements of any professional accrediting agency or of the National Commission on Accrediting, excepting its own membership. Its interest is in the educational effectiveness of the institution as a whole, viewed in the light of each institution's own aims and purposes.

I should like to close with a slight paraphrase of a recent statement made by Chancellor Kimpton of the University of Chicago:

"To change if it is done wisely is to progress. To resist change is to bear witness to the quality and distinction of what we already possess. So long as we do both these things with vigor and with vehemence you need have no worries about the future of your" accrediting affairs, engineering education, and their relationship to the Middle States Association.

In the News

Dr. J. E. Morton, professor of statistics at Cornell University, Ithaca, New York, has been appointed consultant on industrial research to the **National Science Foundation.**

Opportunities for University Research in Heat Power*

By R. G. FOLSOM

Professor of Mechanical Engineering and Director of Engineering Research Institute, University of Michigan

The theme for the session "What is our job in Heat Power Education or Research?" presents a challenging question for consideration. As a start it might be well for us to define what we mean by research. In the broad sense, research may be considered as the individual or group effort of critical and exhaustive investigation toward discovering new facts or devising old methods or theories. It is essential that this investigation shall result in an original contribution to the field of knowledge concerned. It has been common practice to classify research into three general headings. First, basic or fundamental research; secondly, applied research; and thirdly, development. A recent survey of the engineering schools by Ralph Morgan of the National Science Foundation shows that the educational activities of a college or university in engineering associated with research should be about half basic and half applied, with no effort being devoted to development. Although the implication that engineers should not be concerned with the development phases of research is far-reaching and important, this phase will not be considered in detail in these remarks.

Staff members at colleges and universities undertake research activities in the field of engineering for the education of students and staff, as well as for the purpose of making a contribution to the available knowledge in the field of engineering. The emphasis and encouragement of research activities varies from school to school, and is frequently limited by the availability of funds and the assignment of staff time for this activity. It should be noted that research is the very heart of graduate work, and as a result, an essential element in staff activity in any school engaged in graduate instruction.

Scope of Activities

In considering applications of research to heat power, a definition of the scope of activities is desirable, one such being "the broad field of machines which use a working substance, subject to thermodynamic variations." The differences in basic and applied research will be considered with respect to the field of heat power. This is important since what is considered as basic research in engineering might be applied research in mathematics, physics, or chemistry. For our purposes, we will consider basic or fundamental research as that creative effort which results in new information having no direct application to any design, machine, or process. Applied research, on the other hand, refers to that creative effort which results in new information directly useful for design, machines, or processes associated with heat power. It should be noted that performance testing of equipment is not research in the sense discussed here, unless such performance

* Presented at the Annual Meeting, A.S.E.E., Heat Power Section, University of Florida, June, 1953.

tests result in an analysis which presents unique information.

During this meeting of this Society, considerable discussion has developed in connection with the accreditation of engineering curricula. Some recommendations regarding professional-general and professional-scientific engineering curricula have been proposed by the Committee on Evaluation of Engineering Education. Research in heat power engineering can be directed toward either the professional or scientific activities of the field. "This professional engineering activity is characterized by the economic design of high level, non-routine problems requiring integration of the results of scientific research. It is further identified by synthesis, judgment, compromise, and feasibility." (This definition is taken from a recommendation of the Graduate Studies Division of the A.S.E.E.)

The activities in the field of heat engines may be classified as basic operations, combined operations, and performance of machines in plants. What is meant by basic operations may be defined through consideration of combustion. The basic or fundamental operations underlying combustion may be considered as dynamics, fluid mechanics, heat transfer, mass transfer, reaction kinetics, and thermodynamics. Taken alone as individual subjects, basic research will be found applicable to investigations in these fields of science important to engineering. When the phenomenon of combustion is concerned, the basic operations are no longer independent but mutually affect one another. In order to investigate combustion phenomena, it then becomes necessary to consider the combined operations. On the other hand, combustion may be considered as a basic operation to steam production, which is composed of many basic operations. Steam production is of course one of the combined operations making up the steam power plant as a whole.

Research Problems

Research opportunities at a university or college are concerned primarily with the basic operations. This limitation is the result of limited funds, manpower, and equipment available to undertake investigations. In the event that combined operations and plant performance research is to be undertaken, aid from external sources in the matter of equipment and funds becomes of prime importance. It should be remembered that a college or university has many specialists on its staff who are available for consultation, and thus the educational institution can make major contributions to research through the efforts of the staff members.

If we assume for the time being that activity in research is a desirable effort in the field of heat engines, the usual staff member is confronted with the problems of what is an appropriate topic, what are the sources of funds, can additional assistance be obtained, and what can be done with the results.

Many considerations are involved in the selection of a suitable topic, but the major requirement is the enthusiastic interest of the man undertaking the investigation. We have indicated that consideration of the basic operations is the most fruitful field for research in educational institutions.

Using the list of theses in the Division of Mechanical Engineering at Berkeley for typical examples of subjects of interest to heat power engineering, particularly in the basic operations of fluid flow and heat transfer, we find the following examples:

1. Turbulence in Liquid Pipe Flow.
2. Local Boiling on Vertical Tubes.
3. Viscosity of Gases at Elevated Temperatures.
4. Stability Considerations in Vertical Annular Two-Phase Fluid Flow.
5. Accuracy in Reading Aircraft Instrument Dials as a Function of Time of Observation and Dial Brightness.

6. A Calorimetric Determination of the Constant Pressure Specific Heats of Carbon Dioxide at Elevated Pressure and Temperatures.
7. Performance of a Variable-Compression Engine at Elevated Temperatures.
8. A Water Channel Analogy to a Problem in Gaseous Combustion.
9. Heat Transfer to Mercury in Turbulent Pipe Flow.
10. Heat Transfer and Pressure Drop for Air-Water Mixtures Flowing in a Horizontal Tube.
11. Mass Transfer in a Rising Bubble.
12. An Experimental Investigation of Convective Heat Transfer to Air from a Flat Plate with a Stepwise Discontinuous Surface Temperature.
13. Effect of Packing Density in a Cross-Flow Cooling Tower.
14. Starting Thrust Loads for Deep-well Turbine Pumps.

In addition a study of "Review of Current Research and Directory of Member Institutions" made by the Engineering College Research Council of the American Society for Engineering Education will be helpful.

Research Support

Funds to support research are available from many sources, and the following gives some indication of the possibilities. Usually the university or college has limited funds available for research, either by departmental appropriations or by special appropriations earmarked for specific investigations. Industrial companies have established fellowships to aid graduate students in doing research. Most of the engineering societies have limited funds available to support research, as for example, the A.S.M.E. Fluid Meters Committee, which has supported and is supporting research and testing activities at several universities. Foundations have made large sums of money available for research activities, such foundations being Carnegie, Rockefeller, Guggenheim, and the Research Corporation. Recently, large sums of money have been available for research activities in colleges and universities from various government departments, particularly those associated with defense. Some of these are the Office of Naval Research, National Advisory Committee for Aeronautics, Bureau of Ships, the Signal Corps, Office of Ordnance Research, Office of Scientific Research, National Science Foundation, and the National Research Council.

As noted previously, research may be conducted on an individual or team basis. In the event that the work is of such scope that team effort is advisable, the staff members and graduate students available in an educational institution may be utilized. The staff investigator who undertakes a research activity may hire the qualified personnel if suitable funds are available. Or he may make use of professional and non-professional employees of the educational institution and the research activities of graduate students working for their degrees.

In industry the results of research usually appear as patents or new products of the company concerned. In an educational institution (a non-profit organization) the results of research frequently take the form of publications in the transactions of the engineering and scientific societies and the publications of the educational institution.

The opportunities for research in a particular subject in the field of heat power may be limited at any one university or college due to the local conditions. On the other hand, opportunities for university research in heat power are bounded solely by the individual's own limitations. "Where there is a will, there is a way."

ASEE Summer Institutes—1954

Science and technology are moving rapidly ahead in broad areas which hold significant promise for the future of engineering. In order to assure maximum progress in engineering education and to expedite the translation of new fundamental concepts into engineering practice, the American Society for Engineering Education is inaugurating this year a series of conferences to be known as Summer Institutes. This program will help to implement the recommendation of the ASEE Committee on Engineering Education that modern physics, including nuclear science and solid state physics, should become an essential study in engineering education.

Each Summer Institute will deal with a specific subject matter area. The purpose of the Summer Institute is to seek out and clarify fundamental concepts, to assess the material as to its importance in engineering education, and to arrive at a logical orderly pattern for teaching purposes. By this positive approach, it is hoped to bring engineering education into closer proximity to the significant new developments which will affect its future. In these conferences, the divergent viewpoints of the research engineer, the scientist, and the educator will be brought to bear upon the problems.

Two Summer Institutes are planned for 1954—one in Sold State Physics in Engineering Education and the other in Nuclear Physics in Engineering Education. Both conferences will be financed by grants from the National Science Foundation. Each Summer Institute will consist of a working conference of 20 to 30 leading authorities in the particular field who will make a comprehensive analysis of the material and lay the groundwork for the open conference. The open conference will feature about 6 to 8 of the participants of the working conference, discussing important fundamental concepts and organization of the subject matter as it relates to engineering and engineering education. There will be ample opportunity for open discussion by those in attendance.

These conferences are supported in part by grants from the National Science Foundation. The American Institute of Physics is cooperating in the Nuclear Science Foundation.

Solid State Physics in Engineering Education

University of Illinois—March 8–10, 1954

This will be a working meeting of leading physicists and engineers specializing in this field. Attendance by invitation only.

Carnegie Institute of Technology—June 21–25, 1954

Open to engineering and physics teachers. Attendance will be limited to 150. For information and registration forms write to Professor John W. Graham, Carnegie Institute of Technology, Pittsburgh, Pa.

Nuclear Science in Engineering Education

Columbia University—April 22–24, 1954

This will be a working meeting of leading physicists and engineers specializing in this field. Attendance by invitation only.

Northwestern University—September 7–11, 1954

Open to ASEE members. Attendance will be limited to 100. For information and registration forms write to Professor Robert L. Young, Technological Institute, Northwestern University, Evanston, Ill.

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ASEE Summer Schools—1954

The following Summer Schools, sponsored by ASEE Divisions, are open to ASEE members. For information and procedures as to registration, please write to the person indicated in connection with the particular Summer School. All of the Summer Schools at the University of Illinois either precede or follow the Annual Meeting so that those in attendance can combine Summer School attendance with attendance at the Annual Meeting. The program for the Annual Meeting of the ASEE will be mailed to Society members during the last week of April.

Economics of Engineering Summer School sponsored by the Engineering Economy Commitee.

Theme: "An Evaluation of Analytical Techniques of Engineering Economy."
Time: June 12–13, 1954. *Place:* University of Illinois, Urbana, Ill.
Information: Professor Arthur Lesser, Jr., Head, Industrial Engineering Dept., Stevens Institute of Technology, Hoboken, N. J.

Electrical Engineering Summer School sponsored by the Electrical Engineering Division.

Theme: "The Elements of Design of Digital Control Circuits."
Time: June 18–20, 1954. *Place:* University of Illinois, Urbana, Ill.
Information: Dr. L. V. Bewley, Dean of Engineering, Lehigh University, Bethlehem, Pa.

Summer School in Advanced Engineering, with Emphasis upon Development of Creative Thinking jointly sponsored by Educational Methods Division and General Electric Co. Attendance by invitation only.

Time: Aug. 30–Sept. 4, 1954. *Place:* Schenectady, N. Y.
Information: R. H. Buescher, Technical Education, General Electric Co., Schenectady, N. Y.

Workshop for Humanistic-Social Project sponsored by Humanistic-Social Division.

Time: June, 1954. *Place:* University of Illinois, Urbana, Ill.
Information: Professor Sterling Olmsted, English Dept., Rensselaer Polytechnic Institute, Troy, N. Y.

Engineering Mechanics Summer School sponsored by the Engineering Mechanics Division.

Theme: "Evaluation of the Engineering Significance of Graduate Training in Mechanics."
Time: June 11–12, 1954. *Place:* University of Illinois, Urbana, Ill.
Information: Professor Dan Pletta, Virginia Polytechnic Institute, Blacksburg, Va.

Summer School sponsored by the Mechanical Engineering Division.

Theme: "Teaching of Machine Design and Manufacturing Processes."
Time: June 18–25, 1954. *Place:* University of Illinois, Chicago, Ill.
Information: Professor K. E. Lofgren, Machine Design, Cooper Union, New York, N. Y.

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Symposium on Instrumentation Education

Co-Sponsors: Instrument Society of America and American Society for Engineering Education.

Location: University of Illinois, Urbana, Illinois.

Date: June 12, 1954.

Purpose: To focus attention on the concepts, subject matter, and methodology of technical instruction in the broad areas of measurement, computation, control and systems studies. Chairman: Professor R. J. Jeffries, Michigan State College, East Lansing, Mich.

8:00– 9:30 A.M. Registration.

9:30–11:30 A.M. Universal Characteristics of Instruments—H. C. Roberts, University of Illinois.
Situation Analysis in Instrumentation—W. McKay, MIT.
Concepts in Measurement—D. J. Montgomery, Michigan State College.
Computation and Computers in Engineering and Science Curricula—L. L. Rauch, University of Michigan.

Industry Comments.

Discussion.

12:15–1:30 P.M. President's Luncheon—Speaker: W. A. Wildhack, President, ISA.

1:45–3:45 P.M. Teaching Control Engineering—R. W. Jones, Northwestern University.
Teaching Systems Engineering—H. Sohon, University of Pennsylvania.
Teaching Instrumentation Engineering—C. S. Draper, MIT.

Industry Comments—H. W. Cory, Allis-Chalmers Co.

Discussion—A. F. Perry, Panellit Corp.

4:00–5:00 P.M. Inspection of University facilities for research and teaching activities in measurement, computation and control.

Graduate Professional Education in Engineering*

By M. P. O'BRIEN

Dean of Engineering, University of California, Berkeley

The proposal made is simply that one branch of the graduate program in engineering be truly professional in character, with the primary emphasis on the solution of novel and difficult engineering problems. Such a program should parallel and not replace the traditional masters and doctors programs in which research in the engineering sciences forms the central activity. Many individual graduate students have probably been permitted to follow a plan of this type and it may be well-established in some American schools but, if so, the writer is not aware of this development. In many European schools, the program leading to the first engineering degree is of this general character.

Engineering education in this country was organized in response to the demand for men capable of participating in the rapid national expansion of the last century. The initial pattern was derived from schools established somewhat earlier in Europe but was modified to meet our own needs. The Land-Grant College Act aided in expanding this type of education. In the early days of engineering education it was not evident that science could contribute directly to the solution of engineering problems and, in fact, there were few demonstrations of this applicability. Early instruction dealt chiefly with the art of engineering; courses were practical in nature; professors were drawn from practice and gave a great deal of their lecture time to discussions of existing engineering works. Later, the curricula in the engineering colleges were modified to give greater attention to the basic and engineering sciences for two very good reasons. In the first place, there was the need to give engineering academic respectability. This was accomplished by greater emphasis on chemistry, physics, mathematics and such engineering sciences as strength of materials, analytical mechanics and so on. Secondly, there was increasing evidence that a knowledge of science could and did contribute directly to the successful practice of engineering. With the total time limited to four years, this increasing emphasis on science necessarily resulted in a decrease in attention to professional studies and on the whole this change was desirable and beneficial. However, in the course of making these changes, there has developed the implied assumption that engineering consists solely in the application of science; more important still, that those who are well grounded in science are automatically well qualified as engineers. This concept has led, I believe, to an undue emphasis on scientific knowledge and to a de-emphasis on the application of knowledge to the solution of engineering problems. It is this general subject which I will discuss.

Expansion of Graduate Study

The four-year undergraduate program has been the basis for successful engi-

* Presented at the Annual Convention of the Association of Land-Grant Colleges and Universities at Columbus, Ohio, Nov. 11, 1953.

neering practice on the part of all but a small fraction of the profession. In the face of this record of success, why should there now be an expansion of graduate study, especially study of a professional character? My answer is that the tools which the engineer will use in the future will continue to grow in number and complexity and that a longer period of education is required for their effective use. There will always remain a large volume of work in the technical field for which the four-year program will provide adequate preparation. However, there is a rapidly widening segment for which additional study is now highly desirable and for which an additional one to three years of graduate study will be regarded as essential in the not very distant future. Probably, seventy-five per cent of the B.S. graduates in engineering would not benefit from additional study but the remainder will, I believe, find themselves handicapped unless they somehow continue their formal education. The percentage now choosing to engage in graduate work is much less than the twenty-five per cent who are qualified and for whom such work would be beneficial.

Why do so few B.S. graduates in engineering choose to pursue graduate studies? One reason is that the engineering faculties have themselves regarded the four-year program as adequate preparation for practice and have, more frequently than not, implied that graduate study was a frill, unnecessary for serious practitioners. Industry has not strongly supported the position of graduate study in the overall professional scene and the professional societies have not, until recently, formally recognized it as a necessary part of the pattern of engineering education. Even more important, perhaps, is the apparent lack of financial encouragement to the holders of advanced degrees. These and other circumstances are often cited to explain the lack of interest in graduate study among B.S. engineering graduates. There is, I believe, a more fundamental reason for this situation, namely, that graduate study in engineering as now organized does not fully meet the needs of the profession and would not benefit a majority of those who should proceed beyond the four-year course.

Engineering education like professional engineering practice is plagued with confusion and haziness regarding the terms used. Even the word engineer is the subject of controversy. In order that there be no misunderstanding regarding what I have in mind when I speak of professional engineering, science, and engineering science, I will take time to define these terms.

Engineering

Engineering is frequently referred to as the application of science—with the implication that all engineering works were preceded by corresponding discoveries in basic science. This description of engineering is not only oversimplified but is historically incorrect. Bridges, irrigation systems, aqueducts, and even the steam engine, were built without benefit of scientific principles; today, large segments of engineering practice depend more on experience, judgment, and "rule of thumb" than on science. This situation, affecting some but not all branches of engineering, does not result from ignorance or stupidity on the part of engineers but rather from the absence of general relationships permitting a more analytical and scientific approach.

What, then, is the nature of engineering? The characteristic engineering activity is the design or planning of machines, circuits, structures, or processes —and of combinations of these components into systems or plants—and the prediction of their performance and cost under specified operating conditions. Note particularly that "the prediction of performance and cost" is here considered to be the characteristic activity and

that performance is not mentioned alone but rather "performance and cost." Without money considerations and the emphasis on cost, professional engineering would be a different sort of an activity. Prediction of the performance of novel or greatly modified designs is usually more difficult than predicting costs but the two are related, the engineering effort being primarily to discover which design will involve minimum cost.

Whether this definition of engineering is generally acceptable or not, the activity described, namely, prediction of the performance and cost of engineering works, is a major phase of the practice of engineering and one which depends heavily on design methods and information derived from the engineering sciences.

Science and Engineering Science

Research is a search for truth. In the physical sciences, research aims at discovering new facts and new relationships in nature. The velocity of light, the temperature of the sun, the composition and structure of a mineral are examples of facts resulting from scientific exploration. When such facts are related to other facts in a quantitative way the result is called a law of nature. Newton's law of universal gravitation, Archimedes principle governing the buoyancy of submerged bodies, and Einstein's theory of relativity are examples of these relationships. The complexity of nature, considered in large aggregations, is so great that scientists working in the basic sciences have been forced to think about, and experiment on, idealized and simplified systems, such as frictionless fluids, particles in high vacua, processes in reversible equilibrium, perfectly elastic bodies, and so forth. In spite of these limitations, the results of scientific research have been of great practical value and have affected profoundly the daily lives of all of us.

Just how can these scientific facts and relationships be translated into forms useful to society? Did the discovery of Newton's laws produce directly a watch or a gyroscope? Did the discovery of nuclear fission produce an atomic bomb? The answer is, of course, that there is a long and frequently tortuous patch between the discovery of a new physical fact or relationship and its incorporation into useful "hardware." The phenomenon of atomic fission made a bomb possible in principle—but much work and many dollars were required before the bomb became a reality. It is the area between the basic sciences and engineering design in which lie the engineering sciences.

The terminology of this subject is not well established, even among engineers. The *engineering sciences* include such technical subjects as fluid mechanics and its subdivision aerodynamics, thermodynamics and heat transfer, metallurgy, combustion, acoustics, electronics, and many others. The term *applied science* is some times used but *engineering science* more accurately describes the relationships involved. The better known and most widely used of these subjects, in one guise or another, form the core of the conventional curricula in the engineering colleges.

I have taken time here to define my concept of engineering, of science, and of engineering science because graduate study in engineering has in the past aimed chiefly at extension of the student's background into the engineering sciences; only to a limited extent has it been concerned in any direct fashion with preparation for professional engineering. A large fraction of the graduate students in engineering schools should continue to concentrate their efforts on research in the engineering sciences.

Problems of Engineering Education

The engineering colleges have pursued a number of objectives in preparing their

educational programs. All of them hope that their work will prepare their graduates for creative work in the engineering field. Their efforts in this direction are, however, beset by a number of conflicting conditions which should be kept in mind. In the first place, the practice of engineering requires a degree of conservatism which is not characteristic of scientists. The engineer who experiments with his client's money by introducing new and untried concepts or materials is not true to the traditions of the profession. An engineer must review what has been done of a similar nature, must weigh the evidence for introducing a new material or new method of design, and must in many ways show a high regard for past experience. Engineering schools and engineering professors reflect this attitude; perhaps reflect it so strongly at times as to avoid the new concepts which will characterize engineering practice in the future. This characteristic conservatism conflicts in many ways with the development of ingenuity, creativeness, and originality in the student. It is difficult to ask a man to be both conservative and original at the same time but both are necessary characteristics of the engineer practicing in an advanced field in which new applications of science are being made. Another factor is the evident necessity for placing great emphasis on knowledge in engineering education; however, knowledge alone will solve almost no problems of consequence. If one can "know" the solution to a real problem, it is not an important one. It is necessary that the student acquire and exercise as early as possible the ability to apply his knowledge to the solution of novel problems and this is not an easy prescription to fulfill. A third consideration is that a large percentage of the professors in engineering colleges are not in reality professional engineers. This situation is understandable; few young men who choose engineering in college do so with the expectation of becoming professors. Thus there are engaged in the formulation of programs of engineering education, a group who, in general, are not intimately and personally familiar with engineering practice. A fourth consideration is that the practice of engineering in this country involves the organization of teams of engineers who by their combined effort make up for the fact that the inventive genius is rare and cannot possibly be distributed equitably among the companies and agencies of government who need technical services. Any one company cannot depend for its future growth on employing and developing the genius of a Ford or an Edison or a Westinghouse; industry has assured itself slow but steady progress through the organization of groups of men with technical educations. The education of these average, rather than unusual, men engages the major attention of the engineering colleges.

Original Premise

Engineering curricula have, in their evolution from descriptions of empirical arts to professional programs of an analytical character, tended to retain, nevertheless, their original premise that the practice of the future would not change substantially from that of today. Science has been added but narrow specialization remains. Engineering educators should consider carefully the warning of Vannevar Bush who stated in a recent speech:

"Specifically, there may be a tendency to turn to the engineer only for those things that are so matured that they have begun to appear in handbooks, and to turn to the applied scientist for a novel approach—for the new and pioneering activity that is especially attractive from an intellectual standpoint. Much of the training of engineers leads to a compartmentalization that contributes directly to this tendency. Who would think of tossing to a young electrical engineer a tough problem in the chemical engineering field? Yet this is just the sort of thing that we must expect as our industrial effort becomes more ramified

and as the problems we attack become more interwoven with the whole fabric of diversified science that is now being utilized, unless we are willing to abdicate to the applied scientist the most congenial part of the engineer's function. I fear that only too often the young man with a scientific background is more flexible under novel circumstances than is the young engineer, and this is much to be regretted. It is to be regretted because we cannot give up the most cherished attributes of our profession-versatility and resourcefulness—without making our jobs unattractively one sided and conventionally drab."

The late H. P. Hammond stated in Mechanical Engineering:

"Somehow, somewhere in the undergraduate years, the student should be given the opportunity to do a little original work on his own initiative, under guidance of teachers, of course, but not under the close direction which prevails to the end of the curriculum. A great fault of engineering education is to dampen the spirit of enterprize and the desire to create with which most of the students enter college. Instead of tending to stifle originality in our students, the reverse should be the case; we should plan to encourage it. The effects of the introduction of an opportunity for original work on the part of the students is a revealing experience."

If this most desirable objective can be achieved in the undergraduate program, it will be the prelude to the professional graduate program—and perhaps will largely eliminate the need for it. Dean Hammond's statement is effectively a summary of my proposal, transposed to undergraduate years.

Requirements for Successful Engineering Practice

Engineering in the sense defined here is concerned with the expenditure of money—other people's money, public or private—and this responsibility engenders a conservative attitude which accepts innovation only after critical examination. A major problem of the engineer, and of engineering education, is to be conservative and, at the same time, be receptive toward change. An erroneously low estimate of initial or operating costs may lead to an unwise decision to invest; conversely, estimates which are erroneously high may cause the loss of a profitable opportunity. An unduly optimistic or pessimistic feasibility report on a proposed development may be disastrous.

Another major factor in the practice of engineering is the necessity for decision on schedule and on the basis of the data at hand. If the engineer takes time to investigate fully and conclusively every element of uncertainty in a major design problem, the expenditure of time and money would be prohibitive and the results would usually come too late to be of value. Faced with the necessity for decision and conscious of his responsibility for the prudent use of capital, his conservation causes the engineer to recommend that design which, in his judgment, involves the least risk. The engineer should not embark blindly on a program simply to meet a schedule; a more usual difficulty is the inability of engineering graduates, especially in their early years, to reach a decision on the basis of the evidence at hand. One can always imagine many analytical and experimental jobs which should be performed before reaching a decision and thus postpone the fatal day when the decision must be made. However, the engineer who is conscious of the cost of engineering works, realizes that undue delay in making a decision increases the cost and also defers the day when the work itself can become productive.

Impelling Urge

An impelling urge to solve the problem which needs to be solved is, I believe, the most characteristic feature of successful engineer-designers. In this respect engineers differ greatly from sci-

entists. The latter are free to choose their problem. The engineer is forced to solve the problem given him, usually solve it within a time limit. The most successful engineers of my acquaintance are those for whom the strongest motivation is the need for a solution. When their company or their organization is faced with a problem, that problem becomes for them the most important and interesting one they can imagine. If an engineer cannot acquire this viewpoint, he is not likely to be successful.

Engineering work is performed by teams. Few engineering works can be said to have been designed by one man. The ability to cooperate and to fit into an organization is important at the outset; later, the successful engineer will direct the work of other engineers and scientists, many of whom will be the product of educational disciplines different from his own. Not only must he possess the personal qualities for leadership but his knowledge and experience must be adequate for *technical* leadership.

The engineer must develop an intuitive understanding of physical phenomena sufficiently strong to make him "feel" the effectiveness of a proposal, prior to quantitative analysis or experimentation. Study of the basic and engineering sciences, vicarious experience through observation of the works of others, and service under the direction of competent engineers, will develop and strengthen his judgment but, at some point, he must strike out on his own. The earlier he does so, the better off he will be.

Overriding all the preceding requirements for successful practice is that of creativeness—the ability to recognize or imagine the problem, to conceive a feasible solution, to analyze this concept and reduce it to a design, and to bring it to reality in workable "hardware." Perhaps creativeness cannot be developed; it can at least be exercised and the education of engineers should take precautions not to inhibit it where it is latent. There is a shortage of creative engineers. A few such men can generate enough ideas to absorb the energies and talents of hundreds of less gifted engineers, who can analyze, test, report on, optimize, and otherwise polish an original idea but who are not themselves creative. Men of varied talents are needed in the engineering team and all perform valuable services, but the creative individual is essential. He must first be found and then nurtured. The fundamental position of ingenuity and creativeness in engineering practice cannot be overemphasized. Until someone visualizes the basic principles applicable and conceives an assembly of parts which is likely to accomplish the specified purpose, there is nothing to analyze and no subject for the quntitative application of the basic and engineering sciences. True, much of engineering consists in the modification of concepts already applied but this is true of the work of the traditional practitioner and not of the engineer of unusual talents for whom effective graduate study should be provided. No deprecation of the steady, reliable, common-sense designer is here intended; he will continue to perform valuable services as in the past. One is not better than the other; they have different talents and are suited for different types of work. The graduate program should not be opened up to all B-S graduates, most of whom should start acquiring experience as early as possible, but only to those who have shown indications of special talents.

The Graduate Professional Program

What I suggest in the way of a graduate professional program consists in a central core of novel and difficult engineering problems which the students attack, initially in small groups and later, after gaining experience, individually. These design problems should cut across the conventional areas of scientific and professional specialization, as do almost

all problems of engineering practice, and at least a few of the resulting designs should be built and tested. The student should be responsible for choosing and defining the problems attacked and appraisal of his progress should give weight to the significance and importance of the problems chosen.

Primary emphasis on the solution of complete engineering problems will supply strong motivation for studying the related basic and engineering sciences and for reviewing related designs critically as the secondary and supporting part of the student program. Formal courses judiciously selected must be relied on for most of the scientific background but extensive reading and consultation with the faculty will be essential in the solution of suitable problems.

Why not leave professional experience in design problems to practice? Is there a good reason to take time away from course instruction for work of this character? Young muscles are made strong by exercise. True, good food, the right parents, plenty of sleep and other conditions contribute to physical superiority, but the athlete must practice his sport and must do so vigorously enough to develop skill and stamina. There is an analogous situation in engineering practice; a good mind filled with useful knowledge is not sufficient. Interest in the practical solution and judgment developed by experience are essential; delay in applying knowledge to engineering problems may, and in my opinion frequently does, result in mental indigestion. There is for each individual some optimum balance between the rate af acquiring knowledge and exercise in applying it, and it is the purpose of the type of program I have in mind to improve this balance for those students whose ability, interest, and aptitude justify the educational effort. A second reason is to be found in the nature of modern engineering practice, which is almost universally a team effort. The graduate who has not developed some competence in attacking "whole" problems must serve an apprenticeship on routine work under close supervision before he will be given even a minor degree of responsibility. This situation results in further delay of the time when the young engineer faces the problems of independent design. A substantial start in this direction should be made early, preferably in the undergraduate years, and a graduate program emphasizing advanced professional studies will satisfy a very substantial need.

It is sometimes said that the student cannot work effectively on the solution of engineering problems until he has acquired and sharpened the necessary tools; he must master all of the basic and engineering sciences before attempting their use. A quotation from Maritain, the French philosopher and educator, is pertinent to this contention:

> "What is learned should never be passively or mechanically received, as dead information which weighs down and dulls the mind. It must rather be actively transformed by understanding into the very life of the mind, and thus strengthen the latter, as wood thrown into the fire and transformed into flames makes the fire stronger. But a big mass of damp wood thrown into the fire only puts it out."

Maritain would probably object to being quoted in support of a proposal for professional education, but learning a great deal about science, without reasoning through to applications, affects the engineering student's "fire" in much the same manner.

Implementation

Implementation of a program of professional education of the type visualized will require the intimate association of a professional engineer-teacher and a small group of students working on problems in the general field of interest and competence of the teacher. Organization on this basis will be expensive

but so is almost all effective professional education. It is my contention that, if engineering schools are to provide the professional practitioners of the future in the numbers and with the ability which will be needed, they must get away from the present mass production type of organization with its inflexibility of program and its emphasis on organized courses and must move in the direction of individual study. In such a program, one is interested both in the results produced and in the processes by which the results are achieved. By this I mean that the appraisal of the student should not be solely in terms of whether he had devised a workable design but rather whether he has, in the course of working out his problem, increased his capacity for the solution of future problems. A technique which might be employed to some extent in the early phase of a program of this type would be to redesign or reinvent existing machines, circuits, structures or processes so that the student might compare his results with those which already had been achieved. The final problems, the master's thesis or the doctor's thesis, should be novel and difficult, should require the application of science, and should create something potentially useful either in research or in engineering practice. It is important that the engineering faculty make available to engineering practitioners the result of research in engineering sciences in such form as to be readily understandable and applicable and, in this process, the graduate student in the professional field can play an important part.

Graduates with the type of background visualized in the preceding remarks are urgently needed in industry and government, not only for engineering work but also to provide a supply of managers—both in engineering work and in general management—for companies engaged in the technical field.

Faculty Need Professional Experience

The most important factor in the success of any educational program is the quality of the faculty provided. Some faculty members do acquire the viewpoint of a professional engineer without themselves engaging in professional practice, but it is my observation that these qualities can seldom be developed to a reasonable degree without substantial professional experience. Consequently, it does appear that successful implementation of this proposal will require men on the faculty who have practiced engineering at an advanced level of responsibility and who have themselves been subjected to experiences which will have impressed upon them the importance of the qualities previously outlined. These qualifications of faculty members for a professional program are difficult to meet because men who have the intellectual ability, the experience, and the viewpoint are in great demand in industry. It is unlikely that the engineering colleges can be fully competitive in salary with industry for men of this calibre, but the salaries must be nearly competitive and other considerations must make up the difference. It is desirable that these faculty members continue to some extent their association with professional practice.

Teaching Tips

Is the Project Method Effective?

By D. G. HUBER

Assistant Professor of Mechanical Engineering, University of Toronto

In the recent admirable report of the Committee on Improvement of Teaching of the ASEE, the project method of teaching engineering was recommended highly as an aid in the development of student resourcefulness and originality. This paper is written in the hope that some benefit might result from the experiences of one who has used this method for several years in the teaching of Hydraulics.

In this subject, as in many others, the customary practice has been to use the laboratory periods to supplement the lecture courses directly, by giving a series of short, difficult, unrelated problems and experiments and requiring written reports on each. This method can be effective in training the student in specific skills, and a great variety of work can be covered in a comparatively short time. Usually, however, inertia dictates the use of the same or similar problems year after year; the interest of the students is maintained with difficulty; copying of reports becomes a problem, and the whole system seems to be directed towards the obtaining of marks and the passing of the final lecture examinations. Certainly, student resourcefulness and originality are not developed, nor is an attempt made to correlate the work of the specific subject with problems of a broader nature such as must be met later in practice.

The project method was attempted at the University of Toronto as an alternative, in the hope that it would be made effective by maintaining the advantages of the above method while minimizing the disadvantages. Each group doing the study averaged in number thirty-five final year Civil Engineering students, and the time allotted was about forty-five hours.

Outline of Project

The problem was the design of a flood control or power project on an existing or fictitious river. Each student worked as a consulting engineer and wrote an engineering report advising on the feasibility and desirability of the project. The illusion of reality was maintained by the requirement that a statement of consulting fees be included with the report. The problem necessitated the use of hydrologic studies, statistical methods, dam design, river hydraulics, turbine selection, highway relocation, electrical load studies and an economic analysis.

Difficulties Encountered

In the three years in which the project method was used many difficulties and criticisms were met in part by changes in the original system. Some of these difficulties and their attempted solutions are listed below.

(a) *The project method tends to cover a broader field, but does it rather superficially.* Proponents of the value of repetition and the disciplines in teaching engineering will object to the project method because there is not enough time nor direction of the students' work to ensure a mastery of engineering skills. This difficulty has been mitigated, to some

extent, by a careful selection of the conditions of the problem, so that a portion of the course which it is desired to emphasize will appear in each student's work, and then informing him that this must be done more thoroughly than the rest, under staff direction.

(b) *Students work at different speeds.* Should a student who works slowly be penalized for not finishing, or should the faster student be held back? There is some merit in learning to pace oneself against time, even at the expense of thoroughness. In this project it was emphasized that the students are working against themselves and not each other. Thus, each was expected to complete the project to the best of his abilities, the faster man getting his reward in the more detail he was able to cover. Marks were given more for the effort and resourcefulness shown than for the final result.

(c) *Students tend to bog down in detail.* It must be pointed out to them constantly that the time spent in details should be relative to the importance of the details to the final result of the project. Thus, the design of a minor element, costing perhaps one per cent of the total, can be done approximately with little effect on the final cost.

(d) *This method encourages over-simplification of a problem.* Because of the emphasis on finishing the work in a certain time, simplifications of the details of the problem must be made. Care must be taken to point out where this is done, what other studies should be made and how the necessary information would be obtained in practice.

(e) *Student Cooperation is essential for success.* It is inevitable that some students with little interest in the subject will attempt to take advantage of the latitude given by this method. On the other hand, it has been found that most students appreciate a change in the old "lock-step" methods and are anxious to do their best. Thus, it is essential that a frank explanation of the theories behind and reasons for the project study be given, together with a plea for cooperation. To ensure this cooperation, a diary of each day's work was compulsory and a frequent inspection of work books was made. Sufficient penalties for non-cooperation were included in the marking system.

(f) *Students have not been pre-conditioned for this method.* Some students are unable to adapt themselves quickly to this method and may flounder for a considerable time unless given some special attention. The diary and the work book enable early detection of this type of student.

(g) *The fear of losing marks reduces the effectiveness of the study.* While competition among students for marks has some desirable features, it tends to stultify resourcefulness in anything but obtaining marks. Everything the student does is coloured by the marks which may be obtained. This can be reduced by emphasizing that marks are given for effort and progress rather than for the best solution. The students are assured that failure will result only from lack of honest effort or a deliberate flouting of the rules.

(h) *The results of the study may be mediocre.* Each report should be read carefully and a written criticism given in which weaknesses in design, analysis and presentation are pointed out.

(i) *The student is not prepared as well for his final examinations as previously.* This may be true if the examination requires merely the parroting back of information handed out in the lectures. Surely the examination should be a test of thinking power and resourcefulness as well as of knowledge.

Evaluation of Results

In the writer's opinion, the project study as described has been a success. Student interest has been more than satisfactory; resourcefulness, initiative

originality have been stimulated; a correlation of Hydraulics with other fields of engineering has been achieved; the importance of economic analysis has been spotlighted; the difficult practice of writing an engineering report has been attempted and the connection between academic theory and practice has been emphasized. In addition, the student has become familiar with various reference sources. He has been treated as an adult and given freedom of choice and action within broad limits. Surely these results outweigh the disadvantages.

The project method is effective—why not try it?

ASEE Annual Meeting Program for Women and Children

University of Illinois, Urbana, Illinois—June 14–18, 1954

Monday, June 14—Welcoming Tea; Family Square Dance and Mixer.

Tuesday, June 15—Trip and Luncheon, Robert Allerton Estate.

Wednesday, June 16—Engineering Properties and Decoration of Dinnerware; Luncheon, Bridge and Canasta, Champaign Country Club.

Thursday, June 17—New Textiles, Their Care and Use; Fancy Ice Cream Demonstration.

A full program for children has been planned, including games, crafts, lunch as a group, swimming and entertainment with engineering wives and children in charge. Be sure to bring your bathing suits and caps!

Baby sitter listings available at Women's Headquarters, Illini Building. Children under four years of age are not eligible for the children's program. Register the children as far ahead as possible for the program so that they can be accommodated.

Candid Comments

Your invitation, on page 223 of the *Journal* for December, is too tempting to resist. The report on engineering integrity by Dean Freund's committee provokes both thought and comment.

It is assumed that this committee has just undertaken the first step in its challenging assignment—defining a general area of ethical motivation as it relates to professional conduct. For it is obvious that before plans can be made for teachers to mix the instruction of ethical conduct in with their instruction of science and technique, it will be necessary to come to grips with specific behavior patterns that are acceptable, or unacceptable, to our profession. Yes, it may be necessary first to reach a common understanding of what constitutes acceptable conduct under quite specific circumstances.

Perhaps there is general agreement among engineers as to the manner in which an engineer should behave under specific circumstances. However, our codes of ethics are not complete in many areas and there is ample, accepted misconduct in some areas as to threaten the maturing of engineering as a profession. I had better give some examples, before this too becomes another general statement of philosophy.

1) All engineers steal ideas. Perhaps the word "steal" is too blunt. The very growth of the profession depends upon a free exchange of information. Taking and building onto another man's ideas is an acceptable, even an essential behavior. The stature of an engineer, and his ability to create and be compensated adequately depend upon his facility in the use of ideas of others and the degree to which he can pile up some new ones of his own. Thus it has become customary to acknowledge the source of ideas, and give credit for accomplishments. Yet, how common it is for an engineer to accept credit for—even seek credit for—ideas stolen from another. Those familiar with engineering literature are aware that occasionally the name affixed to an article is that of the person who had general administrative supervision of the work described rather than the man whose ideas are represented—in fact the man who actually wrote down the words describing those ideas. Co-authorship sometimes eases the twinge of conscience remaining.

In the "promotion" or sales of services it is quite common to overlook or depreciate the accomplishments or ideas of another—even someone in the same organization—in the drive for recognition, advancement or economic advantage. It is all too easy to present somone else's ideas as your own. But it is stealing nevertheless.

2) Too many engineers bear false witness. It is common practice in some areas of engineering employment to create a false picture of the importance or extent of a project, for the intent of expanding an organization or continuing an operation that has no measurable value. Modesty, honesty and accuracy are considered to be secondary in importance to job tenure or advancement in such areas. Or, how often our organized profession has been injured by malicious or uninformed misstatements of fact by a spokesman for one group or another, who seeks competitive advantage for his own small segment of the profession. Yet these spokesmen are occasionally heaped with honor and raised to positions that indicate clearly that their conduct is to be taken as a good example.

3) Too many engineers worship the false god of job security to the neglect

of their own growth and creativeness. This conduct in itself can reduce engineering from the status of a profession to that of a technical occupation. (Indeed it is now so considered by many both inside and outside the group.) The persons who seek job security in legal controls or collective collusion, and neglect or refuse to expend their own intellect and energies creatively threaten the status of engineering as a profession.

These are but a few examples. They have not been defined clearly. Certainly there is wide difference of opinion as to the point of ethics involved. Yet it is in areas of human relationship such as these that patterns of behavior are developing that will increase the ability of our profession to contribute constructively, and to be recognized for such contributions—or that will reduce the status of engineering. The key is not to be found in more legal controls, or in more vocal "pressure group" operation.

It is heartening to anticipate that Dean Freund's committee will define some of these behavior patterns, seek agreement on the point of ethics involved, and then offer recommendations for effective instruction in such concepts. They should have every encouragement.

Very truly yours,
DON P. REYNOLDS,
Assistant to the Secretary,
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ANNUAL MEETING

June 14-18, 1954

University of Illinois **Urbana, Illinois**

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Section	*Location of Meeting*	*Dates*	*Chairman of Section*
Allegheny	University of Pittsburgh	April 30–May 1, 1954	W. I. Short, University of Pittsburgh
Illinois-Indiana	Illinois Institute of Technology	May 15, 1954	R. G. Owens, Illinois Institute of Technology
*Kansas-Nebraska	University of Nebraska	Fall, 1954	M. H. Barnard, University of Nebraska
Michigan	University of Michigan	May 8, 1954	F. L. Schwartz University of Michigan
Middle Atlantic	Lafayette College	May 8, 1954	H. M. Jenkins, Swarthmore College
Missouri-Arkansas	Missouri School of Mines	April 10, 1954	V. J. Blum, St. Louis University
National Capital Area	Catholic University	May 8, 1954	C. H. Walther, George Washington University
New England	Massachusets Institute of Technology	Oct. 9, 1954	E. R. McKee, University of Vermont
North Midwest	Michigan College of M. and T.	Oct. 8–9, 1954	C. J. Pratt, Michigan College of M. and T.
Ohio	Ohio State University	May 1, 1954	R. S. Paffenbarger, Ohio State University
Pacific Northwest	Oregon State College	April 23–24, 1954	L. Slegel, Oregon State College
Pacific Southwest	California Institute of Technology	Dec. 28–29, 1954	B. M. Green, Stanford University
Rocky Mountain	University of Utah	May 14–15, 1954	A. Diefendorf, University of Utah
Southeast	North Carolina State College	March 25–27, 1954	J. R. Cudworth, University of Alabama
Southwest	University of Texas	April 16–17, 1954	J. J. Heimerich, University of New Mexico
*Upper New York	Cornell University	October, 1954	N. A. Christensen, Cornell University

Members of the Society are welcome at all Section Meetings

* No Date Set.

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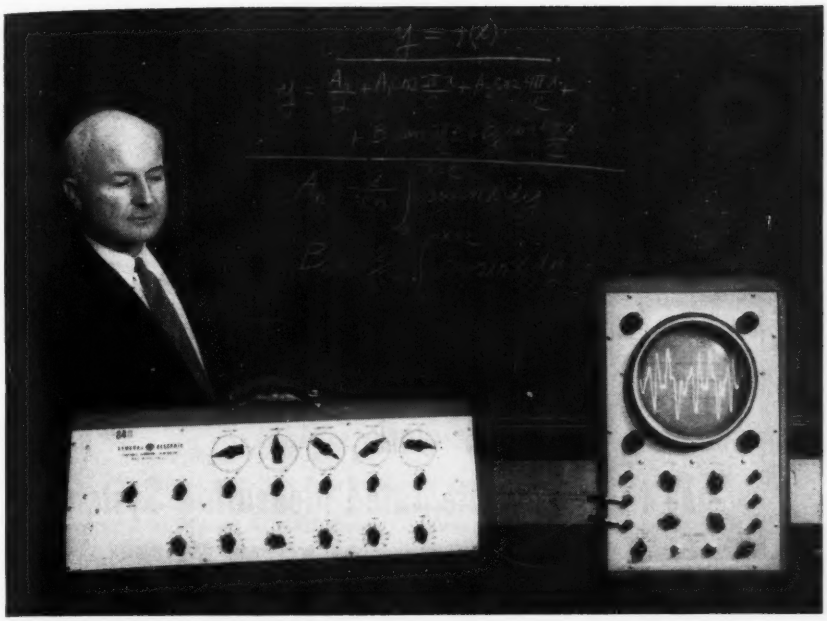

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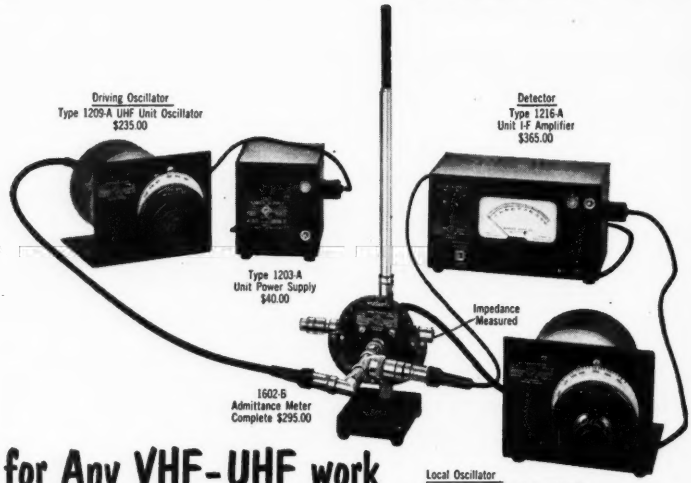

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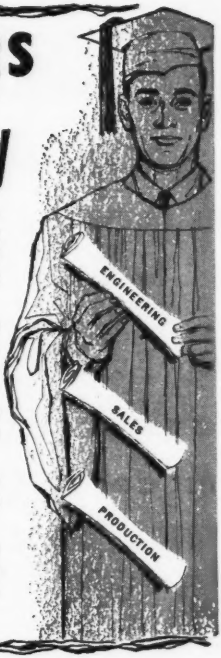

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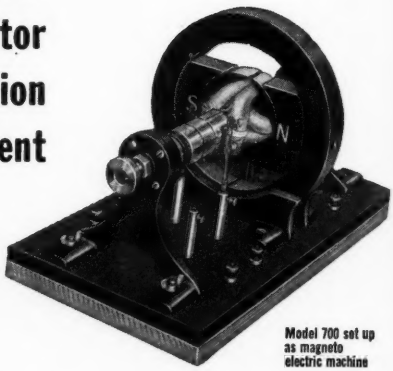

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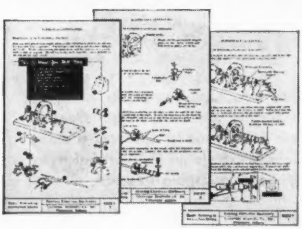

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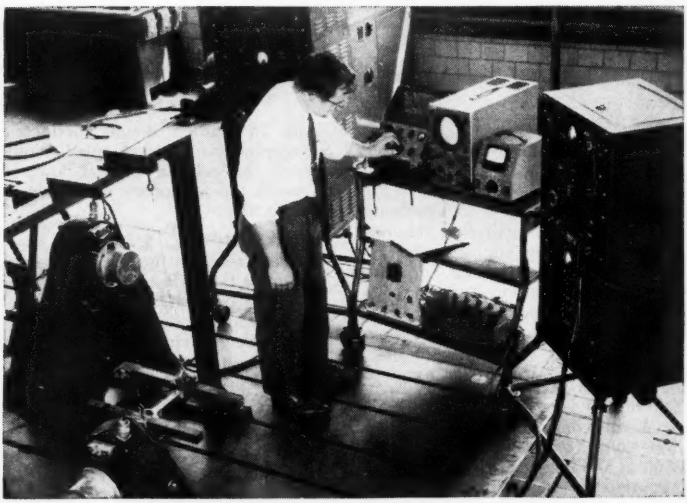

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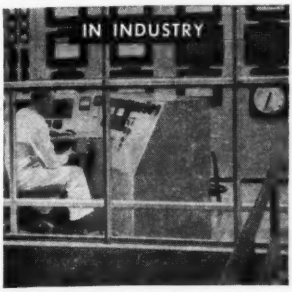

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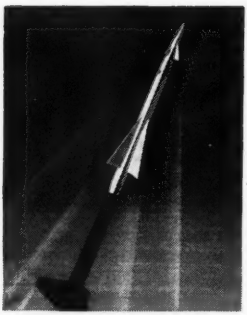

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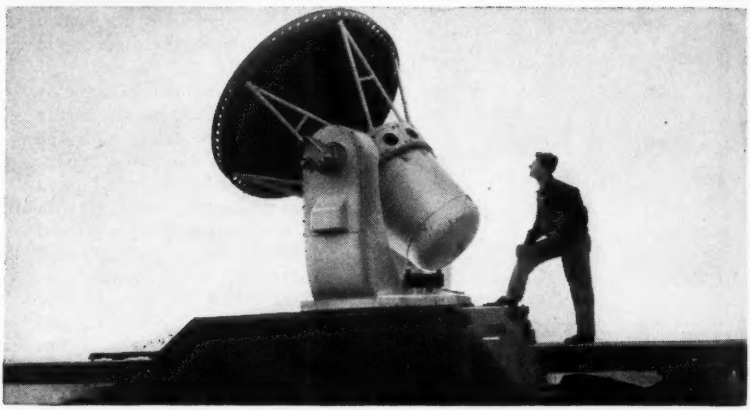

(Upper left) — Nike's missile climbs to destroy an enemy, under guidance of complex electronic controls. A radar is shown at right. Nike (pronounced Ny'kee) is named after the Greek goddess of Victory.

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